# SCIENTIFIC AMERICAN SUPPLEMENT No. 419

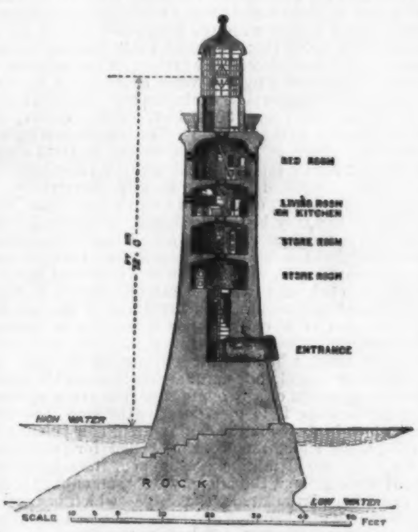
Scientific American Supplement, Vol. XVII., No. 419.
Scientific American, established 1845.

NEW YORK, JANUARY 12, 1884.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

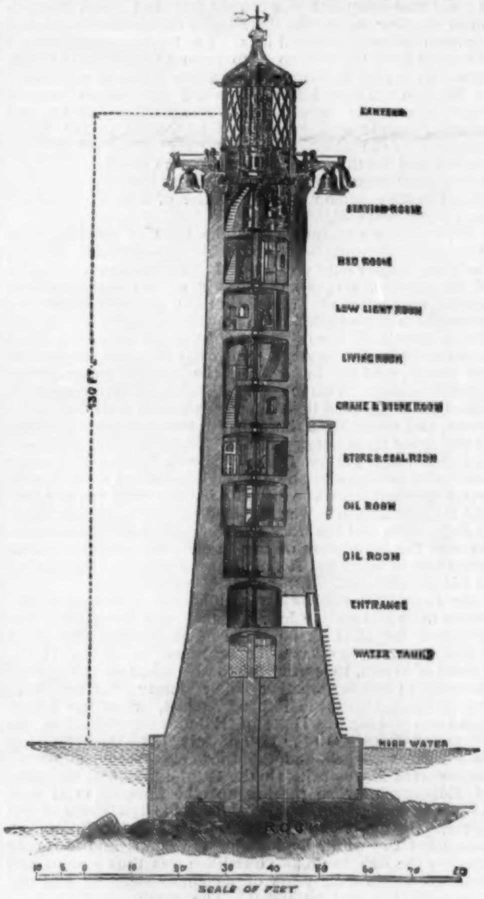

## THE NEW EDDYSTONE LIGHTHOUSE.

AT a recent meeting of the Institution of Civil Engineers, the paper read was "On the New Eddystone Lighthouse," by Mr. William Tregarthen Douglass, C.E. The necessity for the construction of a new lighthouse on the Eddystone rocks had arisen in consequence of the faulty state of the gneiss rock on which Smeaton's tower was erected, and the frequent eclipsing of the light by heavy seas during stormy weather. The latter defect was of little importance for many years after the erection of Smeaton's lighthouse, when individuality had not been given to coast lights; but with the numerous coast and ship lights now visible on the seas surrounding this country, a reliable distinctive character for every coast light had become a necessity. The tower of the new Eddystone was a concave elliptic frustum, with a diameter of 37 feet at the bottom, standing on a cylindrical base 44 feet in diameter and 22 feet high, the upper surface forming a landing platform 2 feet 6 inches above high water. The cylindrical base prevented in a great measure the rise of heavy seas to the upper part of the tower, and had the further advantage of affording a convenient landing platform, thus adding considerably to the opportunities of relieving the lighthouse. With the exception of the space occupied by the fresh water tanks, the tower was solid for 25 feet 6 inches above high-water spring tides. At the top of the solid portion the wall was 8 feet 6 inches thick, diminishing to 2 feet 3 inches in the thinnest part of the service room.




All the stones were dovetailed, both horizontally and vertically, as at the Wolf Rock lighthouse. Each stone of the foundation courses was sunk to a depth of not less than 1 foot below the surface of the surrounding rock, and was further secured by two Muntz metal bolts 1⅛ inches in diameter passing through the stone and 9 inches into the rock below, the top and bottom of each stone being fox-wedged. The tower contained nine rooms, the seven uppermost having a diameter of 14 feet, and a height of 10 feet. These rooms were fitted up for the accommodation of the light-keepers, and the stores necessary for the efficient maintenance of the lights; they were rendered as far as possible fireproof, the floors being of granite covered with slate; the stairs and partitions were of iron, and the windows and shutters of gun-metal. The oil-rooms contained eighteen wrought iron cisterns capable of storing 4,300 gallons of oil, and the water-tanks held, when full, 4,700 gallons. The masonry consisted of 2,171 stones, containing 62,183 cubic feet of granite, or 4,668 tons. The focal plane of the upper light was 133 feet above high-water, its nautical range was 17½ miles, and in clear weather it overlapped the beam of the electric lights from the Lizard Point.

The lantern was of the cylindrical helically-framed type adopted by the Trinity House. The glazing was 2 feet 6 inches higher than usual for first-order lights, this addition being necessary to meet the requirements of the special dioptric apparatus. For the white fixed light exhibited from the




SECTION OF THE NEW TOWER.

THE NEW EDDYSTONE LIGHTHOUSE.

three lighthouses of Winstanley, Rudyerd, and Smeaton at the Eddystone the Trinity House determined on substituting, as a distinction, a white double-flashing light at half-minute periods, showing two successive flashes, each of about three and a half seconds' duration, divided by an eclipse of about three seconds. It was also decided to show from a window in the tower, 40 feet below the flashing light, a sector of white fixed light, to cover the Hand Deeps, a dangerous shoal three and a half miles northwest from the lighthouse. It was further arranged that a large bell should be sounded during foggy weather, twice in quick succession every half-minute, thus assimilating the character of the sound signal to that of the light. Two bells of 40 cwt. each were mounted at opposite sides of the cornice, in order that a windward bell might be sounded during fog.

The optical apparatus for the main light consisted of two superposed tiers of lenticular panels, twelve in each tier. Each lens-panel subtended a horizontal angle at its foci of 30 degrees, and a vertical angle of 93 degrees, being 47½ degrees above the central plane of the lens and 44½ degrees below it; and was composed of a central lens and thirty-nine annular rings or segments, there being twenty-one above and eighteen below the central lens. The twelve panels in each tier were fitted together so as to form a twelve-sided drum, each lens having its focus in a common center at a distance of 920 mm. These lenses subtended the largest vertical angle of any yet constructed for coast illumination, the increased angle and consequent additional power being obtained by the adoption of heavy flint glass for the six highest and the three lowest rings of each panel. The light was derived from two six-wick Douglass burners, one being placed in the common foci of each tier of lenses, the illuminant being colza oil.

With a clear atmosphere, and the light of the Plymouth Breakwater lighthouse—ten miles distant—distinctly visible, the lower burner only was worked at its minimum intensity of 450 candles, giving an intensity of the flashes of the optical apparatus of 37,800 candles; but whenever the atmosphere was so thick as to impair the visibility of the Breakwater light, the full power of the two burners was put in action, with the aggregate intensity of 1,900 candles for the lamps, and an intensity of the optical apparatus of 159,600 candles. This intensity was about 23·3 times greater than that of the fixed light latterly exhibited from Smeaton's tower, and about 3,282 times that of the light first exhibited in the tower from tallow candles. The new tower was built at a distance of 130 feet from Smeaton's lighthouse, a large portion of the foundation being laid below the level of low-water spring tides. The estimate for the work was £78,000, and the cost £59,255. The first landing at the rock was made in July, 1878, and the work was carried on until December. Around the foundation of the base of the tower a strong cofferdam of brick and Roman cement was built for getting in the foundations.

By June, 1879, the work was sufficiently advanced for the stones to be laid in the lower course, and everything was arranged for H.R.H. the Duke of Edinburgh, Master of Trinity House, who was to be accompanied by H.R.H. the Prince of Wales, to lay the foundation-stone on the 12th of the month; but the weather being stormy, the ceremony was postponed until the 19th of August, when the lowest stone was laid by the Duke of Edinburgh, assisted by the Prince of Wales. On the 17th of July, 1880, the cylindrical base was completed, and the thirty-eighth course by the early part of November. On the 1st of June, 1881, the Duke of Edinburgh, when passing up the Channel in H.M.S. Lively, landed at the rock, and laid the last stone of the tower. On the 18th May, 1882, the Duke of Edinburgh completed the work, by lighting the lamps and formally opening the lighthouse. The edifice was thus erected and fitted up within four years of its commencement and one year under the time estimated. The whole of the stones, averaging more than 2 tons each, were landed and hoisted direct into the work, from the deck of the steam tender Hercules, by a chain fall working between an iron crane fixed at the center of the tower and a steam winch on the deck of the Hercules, which was moored at a distance of 30 fathoms from the rock. The Town Council and inhabitants of Plymouth having expressed a desire that Smeaton's lighthouse should be re-erected on Plymouth Hoe, in lieu of the Trinity House sea-mark thereat, the Trinity House made over to the authorities at Plymouth the lantern and four rooms of the tower. For taking down and shipping Smeaton's masonry the Hercules was moored at 10 fathoms from the rock, and the stones were shipped, after the removal of the lantern, by her steam machinery, by a process exactly the reverse of that by which the stones of the new tower were landed. After the removal of the structure to the floor of the lower room, the entrance doorway and well staircase leading from it to the lower room were filled in with masonry, and an iron mast was fixed at the center of the top of the frustum.

## MANUFACTURE OF LARGE IRON PIPES.

FOURTEEN thousand tons of pipes is not a small order. It is large enough to make the owners of a foundry, even a large one, feel that the energy usually devoted to finding work may for a while be called upon to do but little. The Widnes Foundry Company, of Widnes, has now under execution a contract for this quantity of pipes, a part of the large number which will be required by the Vyrnwy water supply scheme. For this purpose the company has provided itself with some special plant, although the specialty of its works has long been heavy castings and pipes of all sizes. A large quantity of the 14,000 tons of pipes for Vyrnwy is, however, of great size for water, viz., 3 ft. 6 in. inside, each length weighing about 3 tons 15 cwt. finished, so that it is imperative that every step shall be taken that is necessary to secure economy in all parts of the manufacture of so many large castings, which have to be made at a price demanding the most careful management with a view to securing the lowest expenditure on every detail in the processes of production.

These 42 in. pipes, which are for the new Vyrnwy Waterworks of the Liverpool Corporation, are made in accordance with the plans and specifications of Mr. Thomas Hawksley, M.I.C.E., and Mr. G. F. Deacon, M.I.C.E., of Liverpool. The contract is now rapidly approaching completion, under the supervision of Mr. H. Nicholson, the superintending inspector to the corporation, assisted by Mr. R. Snowden, as resident inspector.

The Widnes Foundry is situated, as its name implies, in the smoky and somewhat odorous alkali metropolis, Widnes, on the Lancashire side of the Mersey, about twelve miles from Liverpool. The foundry is well known wherever alkali and chemicals of almost any kind are manufactured, as it has long enjoyed a high reputation for the high quality of its productions. It seems like sending coal to Newcastle, but it is a fact that its heavy pans for evaporating and for decomposing salt, and for deep caustic pots, are to be found in every quarter of the globe—even the tariffs of "Vaterland" and the United States not being sufficiently prohibitory to prevent their importation. Some of these caustic pots will hold 18 tons, and they themselves weigh about 9½ tons. They are from 2 in. to 2·5 in. in thickness, and by a lengthy experience in the best admixtures of irons which will withstand the effects of the acids on one side and of fire on the other, the Widnes Company has made these pans very durable—though even so they last but about eight months. We are, however, more particularly concerned with pipes. We propose, therefore, to follow a pipe throughout its manufacture, beginning with the raw material.

The works are conveniently situated on the main line of the London and Northwestern Railway to St. Helen's, from which sidings run into them, bringing iron, fuel, etc., alongside the cupolas, which are charged with metal and coke direct from the trucks, thus effecting a considerable saving of labor.

Closely adjoining the cupolas is the pipe "pit," in which the pipes are moulded and cast. Over this pit work two steam traveling cranes on an overhead gantry, running not only the whole length of the foundry, but beyond it, across the yard to the siding before mentioned. These cranes are powerfully driven, and move along the shop at the rate of about 200 ft. per minute when required. The moulds, which are drysand, are made vertically with the sockets downward, the pattern being withdrawn by hydraulic power, and are dried by means of gas flames, the gas for which is produced on the premises by Howson and Wilson's gas-producer, the cores being also dried by the same means.

Considerable care is used in the preparation and drying

Fig. 1

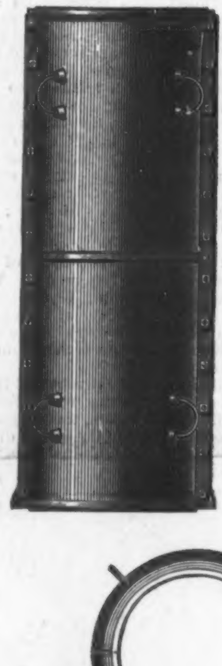


Fig. 2

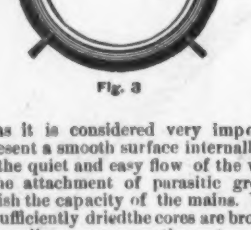


Fig. 3

of the cores, as it is considered very important that the pipe should present a smooth surface internally, so as not to interfere with the quiet and easy flow of the water, or offer facilities for the attachment of parasitic growths, which speedily diminish the capacity of the mains. When moulds and cores are sufficiently driedthe cores are brought forward by one of the traveling cranes over the center of the moulds, and by a special arrangement of the crane are lowered into place with great rapidity. So quickly is this done that the workmen describe the operation as "dropping the cores in," and in a few minutes the mould is ready for casting.

We give a general view of the foundry in which the Widnes Company is making these pipes, and of part of the ground occupied by the testing and coating plant. Some description of what is to be seen during a walk through these parts of the Widnes Works may not be without interest.

Among special tools for making pipes, the moulding box or flask, the mould, and the core frame are leading elements. The moulding boxes at Widnes are long cylinders made in halves and held together by bolts, as shown by the annexed engraving, Fig. 1, or by bolts or cotters put into the notches in the vertical flanges, made as also shown in the annexed engraving, Fig. 2. The latter form is most used, as less time is occupied in putting them together and taking apart. The flasks are about 13 ft. 6 in. in length for pipes which are 12 feet 6 inches in length over all when finished, a head of about 1 ft. in length being cast on the end to secure soundness. The lower end of the flask is bored to fit the base upon which both it and the core stand, and the core frame is turned to fit in a similar way into the base, which is a casting forming a carriage for the spigot end of the mould. The 3 ft. 6 in. pipes are 1·5 in. in thickness, and the flasks are only made large enough to have about 1½ in. of sand all round them, a quantity which would seem to leave a very thin wall of sand. It is, however, found that such a wall stands as well or better than one of greater thickness, and the thin one has the great economical advantage that the time required to dry the mould is reduced to the lowest limit. This is an important consideration, for not only does the number of flasks employed depend upon it, but the size of the casting pit must be larger or smaller according to the number of flasks in use. Thus, by getting the thickness of the sand down to the lowest, several important economical results are obtained, and these are sufficient to make it expedient to have flasks of different sizes for almost every different size of pipe. The pattern upon which the flask is rammed up is about 6 ft. in length for 3 ft. 6 in. pipes. The lower end of this fits into a base, upon which the flask also fits. Upon a stage round the flask four men work with thin T-headed pegging rammers, while two lads fill in the sand. As soon as the sand is rammed up to near the top of the pattern, or to a height of 6 ft., the pattern, which is suspended by a chain from the hydraulic crane, is gradually raised, the hydraulic crane giving it a very steady pull at the rate of about 9 in. per minute, the whole mould being rammed up in from sixteen to eighteen minutes. In the walls of the flasks are holes about 6 in. apart, to facilitate the escape of gas from the sand and through the sand. The casting pit is 40 ft. in length, 25 ft. in breadth, and 12 ft. in depth.

The core carriers are strong castings split at one side, and provided with internal projections on that side, into which fit the wedge surfaces, which are formed on one long bar. When the core is made, this carrier is, of course, extended by the wedges. The core is then dried in ovens, as shown in the drawing, these ovens being heated by means of the gas jets from the Wilson gas producer already referred to. The ovens thus require no attention, and the gas is cheaper and cleaner than coke fires. When dried the core is placed on the base above referred to, the flask lowered over it, and the casting made. The ladles carry about four tons of iron, and a pipe is poured in one minute.

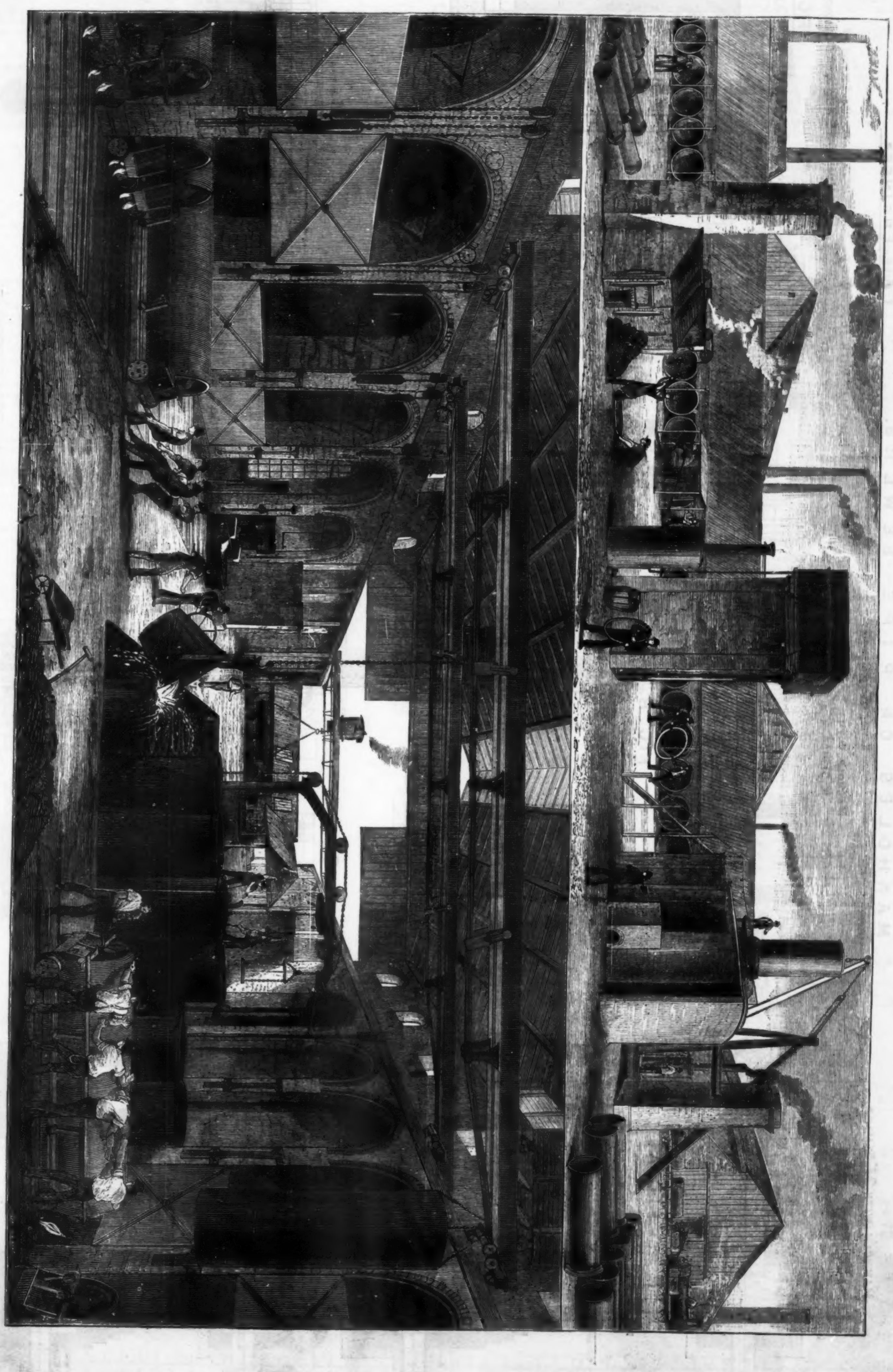
In accordance with the specification, special precautions are taken in the mixture and melting of the metal. In order to preserve the proper mixture of iron, transverse test bars of the same metal are cast with each pipe, and numerous tensile test-bars are also cast of the same iron, all of which are subjected to dead weight tests, a certain proportion of them being also loaded with the prescribed weight for 24 hours, the load being then increased until fracture ensues. Several of these test pieces were broken on the occasion of our visit. Those tested by transverse stress are 2 in. by 1 in., resting upon supports 36 inches apart; one broke with 29 cwt. and the other with 30·25 cwt. on the center, the specified strength being 28 cwt. The tensile strength is ascertained by means of test pieces turned to 1·125 diam., which is 0·994 square inch sectional area, or practically one square inch. Three of these broke with, respectively, 10 tons 16 cwt., 11 tons 16 cwt., and 12 tons 2 cwt. 2 qrs. The quality of the iron may be thus gathered, as it will be seen that the iron is tough as well as of a high tensile strength.

When the pipe has been cast a sufficient time the core wedges are withdrawn, but the pipe is left several hours in the mould to cool, and when sufficiently cooled to be removed without detriment, it is lifted out of the pit and laid on one end of a covered iron gantry to be dressed. As the dressing proceeds it is rolled forward, eventually reaching the lathe, which, while cutting off the head and finishing off the spigot end, simultaneously turns the socket belt for the reception of a wrought iron strengthening hoop. On leaving the lathe it is passed on to the long "proving house," which is shown in the engraving. This is laid with steel rails, along which the pipes are rolled for inspection; here they are each minutely examined, measured, and weighed; the diameter, thickness, weight, amount of socket joint, and other particulars of each pipe—which has cast on it a consecutive number—are carefully taken and separately recorded, and daily reports made to the engineers by their resident inspector. In addition to measurement by gauges to go over the spigots and inside the sockets, the pipes are frequently tested by socketing one into the other, as in laying, and the amount of joint ascertained by the insertion of a gauge. Being found sound so far as can be seen, they are rolled forward on the gantry to be proved by hydrostatic pressure by Mr. Hawksley's new system, in which oil is substituted for the water usually employed. The proving machine consists of two fixed heads, strongly connected together by tie-bars, between which the pipe passes freely; one head contains passages for the supply of oil from a large tank, elevated considerably above the press, the other a large ram which is forced against the pipe after the fashion of the hydraulic press, oil being used, however, instead of water. A joint is made at each end, by means of gaskets, and the pipe rapidly filled with the oil, which is then raised to a pressure equal to 600 ft. or 700 ft. of water, and this pressure maintained for several minutes, the pipe being meanwhile repeatedly struck with sufficient force to produce a strong vibration of the metal. Having satisfied this crucial test, they are rolled onward in the direction of the coating tank, commanded by a tall steam jib crane, as shown in the engraving, and are hooped with a 1¼ square wrought iron hoop shrunk on. This hoop is not only to secure strength in the socket, but to prevent breakage in transit. Being hooped they are now ready for coating, for which purpose they are lifted by the steam crane into an oven, and when sufficiently heated are immersed vertically in a bath of Dr. Angus Smith's solution. When sufficiently cooled they are lifted by the same crane into the railway trucks, and the distinguishing numbers and weights painted inside, the coating examined, and the hoops finally tested by the inspector with the hammer, to detect any possible unsoundness in the welding or looseness in the fit, and are then dispatched. The special pipes and castings, of which, as may be supposed in an undertaking of such magnitude, there are a considerable number and variety, are made in "loam," in a separate foundry, the same precautions being observed in their manufacture as are used in that of the plain pipes. Great importance being attached to the preservation of the pipes from rust, the foregoing operations are carried on under cover, and it is principally for this reason that oil has been substituted for water in proving.—*The Engineer.*

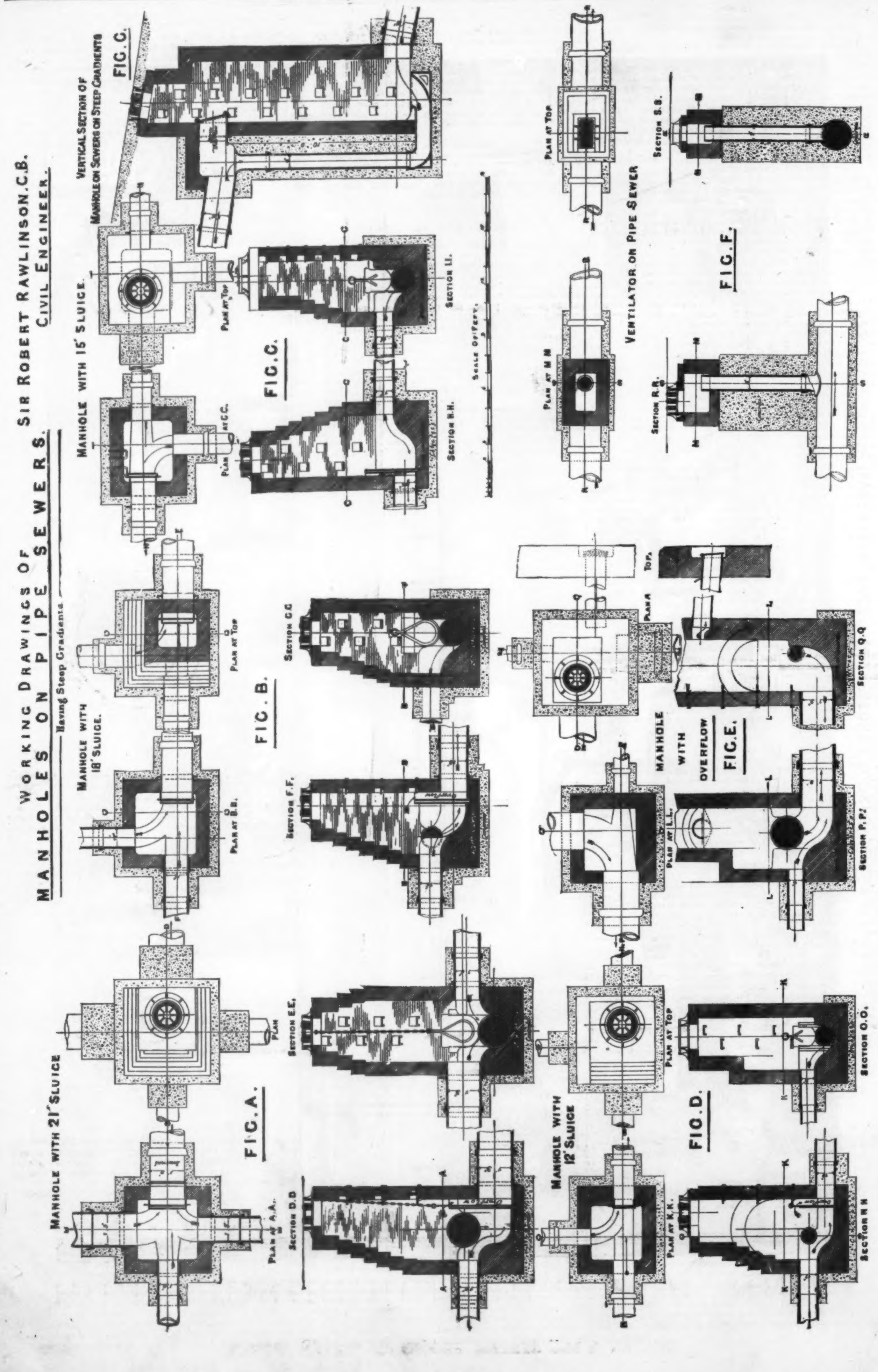
A VARNISH has been patented in Germany for foundry patterns and machinery, which it is claimed dries as soon as put on, gives the patterns a smooth surface, and is a good filler. This varnish is prepared in the following manner:

Thirty pounds of shellac, 10 pounds of Manila copal, and 10 pounds of Zanzibar copal are placed in a vessel, which is heated externally by steam, and stirred during from four to six hours, after which 150 parts of the finest potato spirit are added, and the whole heated during four hours to 87° C. This liquid is dyed by the addition of orange color, and can then be used for painting the patterns. When used for painting and glazing machinery, it consists of 35 pounds of shellac, 5 pounds of Manila copal, 10 pounds of Zanzibar copal, and 150 pounds of spirit.

FOR grinding circular saws, M. Dugoujon, of Paris, replaces grindstones by disks cast with a V groove on the periphery filled in with lead. Pulverized flint or quartz, or sand and water are allowed to drop during the operation of grinding, which is thus accomplished more economically than with stones.



MANUFACTURE OF LARGE CAST IRON PIPES. WIDNES FOUNDRY, NEAR LIVERPOOL.


WORKING DRAWINGS OF
MANHOLES ON PIPE SEWERS.
Having Steep Gradients
SIR ROBERT RAWLINSON, C.B.
CIVIL ENGINEER.
MANHOLE WITH 21" SLUICE
FIG. A.
PLAN AT A.A.
PLAN
SECTION D.D
SECTION E.E.
MANHOLE WITH 18" SLUICE.
PLAN AT B.B.
PLAN AT TOP
FIG. B.
SECTION F.F.
SECTION G.G
MANHOLE WITH 15" SLUICE.
PLAN AT C.C.
PLAN AT TOP
FIG. C.
SECTION H.H.
SECTION I.I.
SCALE OF FEET.
VERTICAL SECTION OF MANHOLE ON SEWERS ON STEEP GRADIENTS
FIG. C.
MANHOLE WITH 12" SLUICE
PLAN AT K.K.
PLAN AT TOP
FIG. D.
SECTION H.H
SECTION O.O.
MANHOLE WITH OVERFLOW
FIG. E.
PLAN AT L.L.
PLAN A
TOP.
SECTION P.P.
SECTION Q.Q
VENTILATOR ON PIPE SEWER
FIG. F.
PLAN AT M.M
PLAN AT TOP
SECTION R.R.
SECTION S.S.

## MANHOLES ON PIPE SEWERS.

THE page, illustrating detailed drawings of manholes on pipe sewers, which we give opposite, has been prepared with a desire to lay before our sanitary engineering readers information which is not generally available. The examples we have reproduced are those furnished by Sir Robert Rawlinson, C.B., in a supplementary sheet published in 1880, and were intended to illustrate the "Suggestions" for main sewering, published by the Local Government Board a year or two previously. To the official description of the several sheets of detailed drawings we must refer for a general view of the suggestions offered. Our illustrations are sufficiently self-explanatory to need little remark. As will be noticed, they are plans and sections of manholes intended to be used with earthenware pipe sewers on steep gradients, though, as Sir R. Rawlinson has pointed out, similar manholes may be adapted to brick sewers. Fig. A represents a manhole at the junction of four pipe sewers at right angles, the incoming sewers being their full diameter above the outgoing pipe sewer. The arrangement for flushing is clearly exhibited, and an overflow escape is indicated between the closed sluice plate and outlet (see section on line D D), the object of which is that the manhole may not be filled above the level of the closed sluice—a very desirable precaution. The construction of the manhole is of brick and cement, the bottom being either so formed or moulded in Portland lime concrete. The manhole cover is circular, and is made with wood blocks to prevent jarring. Figure B represents a similar arrangement for three pipes, having a sluice of 18 in.; and Figs. C and D, designs for manholes with sluices of 15 in. and 12 in. on the same principles. It will be noticed that in each case the bottom of manhole has a good curved fall to the outgoing sewer. In Fig. E we have a manhole showing a pipe overflow for the purpose of relieving the sewer of stormwater. The relief pipe ought to be placed at such a level in the manhole as may be found necessary by the positions of the house connections. The head of water to be removed will of course vary under these circumstances. In the next, Fig. F, we give plan and section of a sewer ventilating pipe. These are 9 in. earthenware pipes fixed at the upper end of sewer and at different points between the manholes. They also serve the purpose of lampholes. The connection is brought up by concrete in which the pipe is embedded, and a small chamber of brickwork in cement receives the upper end of the pipe, and is provided with a grated cover which admits of being taken up for cleaning. Fig. G is a section showing a convenient arrangement for sewers on steep gradients. A 9 in. vertical pipe connects the upper with the lower section. It will be observed a flap-cover storm overflow is introduced at the upper end, so that stormwater would be projected over into the manhole, the more solid matter being precipitated down the vertical connection. By such an arrangement the lower sewer may be well flushed. Though these examples are suggestive of manhole construction, the surveyor will find circumstances compel a modification in some cases.—*The Building News.*

## THE BROOKLYN DRIVEN WELL SYSTEM.

THIS "plant" is situated on a farm about two and a half miles beyond East New York, alongside of the aqueduct which supplies water to the city of Brooklyn. Water is obtained from 100 2-inch tubes (or driven wells) driven from 40 to 100 feet into the ground by means of a simple portable pile driver, worked by hand.

These 2-inch tubes are driven in two rows, the rows being 15 feet apart, and the tubes in either row being 12 feet apart. The space occupied by the tubes or driven wells is thus a small strip of ground about 800 feet in length and 15 broad. The top of each tube just at the ground surface is connected by a cross pipe with a horizontal pipe running along half way between the two rows. Sketch 1 represents a section of one of the wells and the strata—sand and water-bearing strata—through which the well is driven. Sketch 2 represents the plan of the plant, but this particular sketch is taken from a precisely similar plant at Jamaica, a few miles beyond. In this the wells are driven 13 feet apart each way. In every other respect the East New York and the Jamaica plants are alike. Sketch 3 represents the "receiver" with the 16-inch suction pipe which enters the pump house. Sketch 4 represents the details of the connection or cross pipe from one well to the main.

It is found that when a suction pump is attached to this horizontal pipe, water is drawn by suction from all the driven wells at once. Practically the pump is not placed at the end of the system, but midway between the ends, where there is a common receiver for the water arriving from the wells each way. From this receiver a pipe enters the pump house and constitutes the induction pipe to the pumps. From the pump house a discharge or delivery pipe enters the Brooklyn aqueduct only a few feet distant from the pumps.

It is impossible for any one not to experience a peculiar feeling of surprise and wonder when told that this simple plant, without excavations for a large well, without reservoirs, and without long lines of supplying conduits, is furnishing 6,000,000 gallons, or about 25,000 tons, of water daily to the city of Brooklyn. Another similar plant at Jamaica, a few miles beyond, is supplying as much more, or a total for the two stations of 12,000,000 gallons (50,000 tons) daily.

It is unnecessary to give a description of the pumps, as any steam pump or pumping engine is adapted to this work. All that can be seen above ground, as far as the wells are concerned, are the hand wheels of the stop valves, and portions of the valves and connecting pipes, which may, if desirable, appear above the surface, and all of the plant below ground consists of the 100 2-inch tubes driven into the ground.

As a mode of obtaining large volumes of pure water for any purpose whatsoever, but especially for cities and towns, this bold but successful enterprise of the Messrs. Andrews & Co. must be considered a new departure in engineering, and an experiment of great public value and utility.—*W. P. Trowbridge in Sanitary Engineer.*

## IRREGULAR GEAR MOTION.

AN example of the use of mutilated driving gears is to be found in what are known as "dog" cutters, used in paper mills to divide into sheets the rolls of paper delivered from paper making machines. The end of the web of paper is passed between feed rolls which are driven by a gear having part of its teeth removed. At each revolution of this gear, as the plain part passes, the feed rolls are stopped, and a revolving cutter divides the portion of paper already passed out. Many of the driving gear teeth are detachable, changes in lengths of sheets cut being made by the removal or addition of one or more of them. There are some objections to this plan. It requires considerable force to start the feed rolls from a state of rest, partly because of the angle at which power is applied, and this force upon two teeth only, the first tooth of the driving gear and the tooth of feed roll gear it comes into contact with. Consequently the teeth are cut to a coarse pitch, but even then the breaking and uneven wear of the teeth is not uncommon. Often odd sizes of sheets are demanded, and it is necessary to use the number of teeth that will cause the rolls to pass out less than the right quantity of paper, the difference being made up by winding and pasting some paper around the governing feed roll to increase its diameter. A recent practical improvement in this class of gearing is shown in following diagrams. The device consists of the segment, A, mounted concentrically with the driving gear, and having three or more teeth.

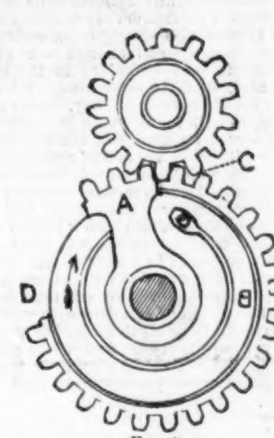



FIG. 1.

This segment is free to swing on the plain part of gear from C to D, but is kept snugly to C, by the spring, B, which is made as light as weight of segment will allow. The operation of the device can readily be seen from Figs. 1, 2, and 3, which show how the segment is led into gear by the fixed teeth at C, and stops in this position (Fig. 2) until the approaching fixed teeth at D come into contact with it and push it forward till it is released (Fig. 3), when the spring returns it to its original position. The segment thus is first brought into gear by the retreating fixed teeth, and then itself leads approaching teeth correctly into mesh, the gears being as continuously connected as if there was no mutilation.

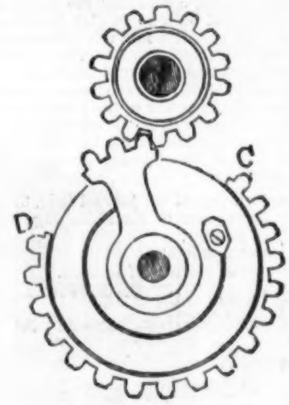



FIG. 3.

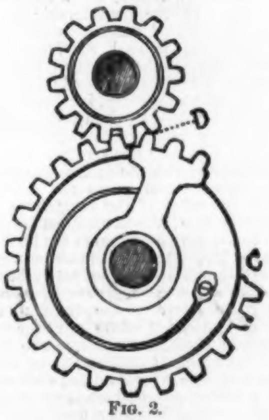



FIG. 2.

Moreover, the strain of starting is reduced and divided between as many teeth as could possibly be in contact at one time, and the teeth can be cut to as fine a pitch as needed without fear of breakage. It is an invention of George White of the Boston Newspaper Union.

GEARS.

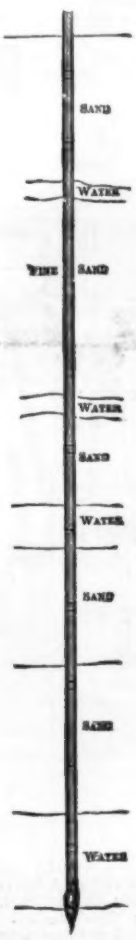



FIGURE 1.


FIGURE 3.

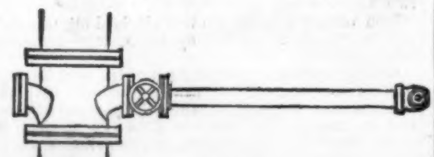


FIGURE 4.

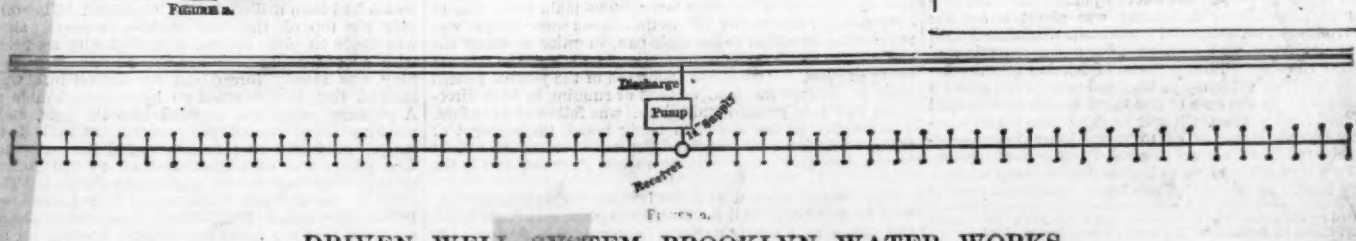



FIGURE 2.

DRIVEN WELL SYSTEM, BROOKLYN WATER WORKS.

## FIRST REPORT ON FRICTION EXPERIMENTS.*

By MR. BEAUCHAMP TOWER, of London.

I. *Description of Machine.*—In experimenting on the friction of lubricated bearings, and on the value of different lubricants, one of the difficulties which is first met with is the want of a method of applying the lubricant, which can be relied upon as sufficiently uniform in its action. All the common methods of lubrication are so irregular in their action that the friction of a bearing often varies considerably. This variation, though small enough to be of no practical importance, and to pass unnoticed in the working of an ordinary machine, would be large enough utterly to destroy the value of a set of experiments, say, on the relative values of various lubricants, for it would be impossible to know whether an observed variation was due to a difference in the quality of the oil, or in its rate of application. The first problem therefore which presented itself, in the present experiments, was to devise a method of lubrication such as would be perfectly uniform in its action, and would form an easily reproducible standard with which to compare other methods. These conditions were best fulfilled by making the bearing run immersed in a bath of oil. By this method the bearing is always supplied with as much oil as it can possibly take, so that it represents the most perfect lubrication possible, and is a good standard with which to compare other methods. It is at all times perfectly uniform in its action. It is very easily defined and reproduced; and it also has the advantage that the temperature of the bearing can be easily regulated by gas jets under the bath. Experiments showed that the bath need not be full; the results obtained were the same when it was so nearly empty that the bottom of the journal only just touched the oil.

The journal experimented on (see sketch annexed, Fig. 1) was of steel, 4 in. in diameter and 6 in. long, with its axis horizontal. A gun-metal brass, A, embracing somewhat less than half the circumference of the journal, rested on its upper side. The exact arc of contact of this brass was varied in the different experiments. Resting on this brass was a cast-iron cap, B, from which was hung by two bolts a cast iron crossbar, C, carrying a knife-edge. The exact distance from the edge of this knife-edge to the center of the journal was 5 in. On this knife-edge was suspended the cradle, D, which carried the weight applied to the bearing. The cap bolts and crossbar were put together in such a manner as to form a rigid frame, connecting the brass with the knife-edge. If there had been no friction between the brass and the journal, the weight would have caused the knife-edge to hang perpendicularly below the axis of the journal. Friction, however, caused the journal to tend to carry the brass, and the frame to which it was attached, round with it, until the line through the center of the journal and the knife-edge made such an angle with the perpendicular that the weight multiplied by the distance from the knife-edge to that perpendicular offered an opposing moment just equal to the moment of friction.

Suppose $r$ = radius of the journal (Fig. 3),
$s$ = distance of the knife edge from the perpendicular,
$w$ = the weight,
Then $s \times w$ = the moment of friction.

Now the friction at the surface of the journal

$$=\frac{\text{the moment}}{r}=\frac{w\times s}{r}.$$

Hence the coefficient of friction

$$=\frac{\text{Friction at surface of journal.}}{w}$$

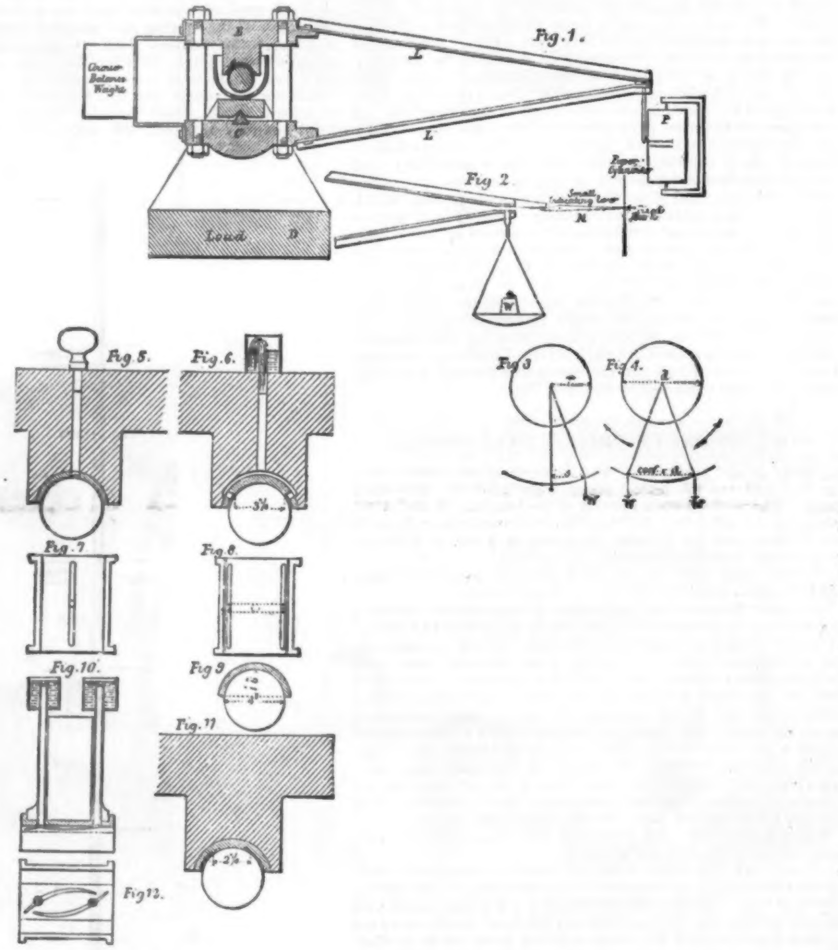
$$=\frac{\frac{w\times s}{r}}{w}=\frac{w\times s}{w\times r}=\frac{s}{r}.$$

So that the coefficient of friction is indicated by $s$ in terms of $r$, no matter what the weight is. As an example suppose $s$ was equal to $r$; the coefficient of friction would obviously be 1; or if $s$ was $\frac{1}{10}$ of $r$, then the coefficient of friction would be $\frac{1}{10}$.

In order to avoid the difficulty of determining accurately when the knife-edge was perpendicularly under the center of the journal (a knowledge which was necessary in order to obtain a measurement of $s$, and which was very difficult to obtain owing to the considerable friction between the brass and the journal when at rest), each experiment was tried with the journal revolving in both directions, and the sum of the values of $s$ on both sides was measured; and then the coefficient of friction was indicated by the chord of the whole angle, included between the two lines of inclination caused by the friction, with the rotation in the two directions, expressed in terms of the diameter of the journal (see Fig. 4). Each result was thus a mean of two experiments, one with the axle running in one direction and the other with it running in the other direction. In order to read the value of the coefficients thus obtained, a light horizontal lever, L, was attached (as shown in Fig. 1) to the frame connecting the brass to the knife-edge. It was 62½ in. long, or 12½ times the distance between the center of the journal and the knife-edge; so that at the end of the lever the chord indicating the coefficient of friction was magnified 12½ times. As a chord of 4 in. at the knife edge represents a coefficient of 1, a chord of 50 in. at the end of the lever also represents a coefficient of 1, while 5 in. represents a coefficient of $\frac{1}{10}$, ½ in. of $\frac{1}{100}$, and $\frac{1}{20}$ in. of $\frac{1}{1000}$. The position of the end of the lever during each experiment was recorded by a tracing point attached to the end of the lever, and marking on metallic paper fixed on a paper cylinder, P. The distance between the two lines obtained by running the machine both ways, when measured on the above scale, indicated the value of the coefficient.

II.—*Method of Experimenting.*—Early in the experiments it was found that immediately after the motion of the shaft was reversed, the friction was greater than it was when the shaft had been running in the same direction some time. This increase of friction, due to reversal, varied considerably. It was greatest with a new brass, and diminished as the brass became worn, so as to fit the journal more perfectly. Its greatest observed amount was about twice the normal friction at starting, and it gradually diminished until the normal friction was reached after about ten minutes' continuous running. This increase of friction was accompanied by a strong tendency to heat and seize, even under a moderate load. In the case of one brass, which had worked for a considerable time without accident, and had consequently become worn so as to fit the journal very accurately, this tendency to increase of friction was accompanied by a strong tendency to heat and seize, even under a moderate load. In the case of one brass, which has worked for a considerable time without accident, and had consequently become worn so as to fit the journal very accurately, this tendency to increase of friction after reversal almost entirely disappeared; and it could be reversed under a full load without appreciable increase of friction or a tendency to heat or seize. The phenomenon must be due to the surface fibers of the metal, which have been for some time stroked in one direction, meeting point to point, and interlocking when the motion is reversed. The very perfectly fitting brass was probably entirely separated from the journal by a film of oil; and there being no metallic contact the phenomenon did not show itself. In consequence of the above facts it was found necessary to proceed with the experiments in the following order. A complete series of experiments, with a gradually increasing load, was taken with the journal running in one direction; the load was then diminished by the same steps as it had been increased, and the experiments thus repeated, the shaft still running in the same direction, until the load had thus been reduced to 100 lb. per square inch, which was the load due to the unweighted cradle. The direction of motion was then reversed, and the shaft run for half an hour, so as to get it thoroughly used to going the other way; after this the load could be increased and the experiments taken without any difficulty. The experiments, as before, were taken at each step of both increasing and decreasing the load; so that each recorded result is really the mean of four experiments, which have in many instances been taken several hours apart.

This method of obtaining a direct indication of the coefficient of friction, by the angular displacement of the frame connecting the brass and knife-edge, would have undoubtedly been the best had the coefficient of friction been nearly as constant as it has hitherto been supposed




FRICTION APPARATUS.

to be. But as shown by the tables of results, the coefficient of friction was found, instead of being constant, to vary nearly inversely as the load, and also to be much smaller in quantity than was expected; the consequence was that with high loads the height of the diagram was very small. In the cases where with the greatest loads a coefficient of $\frac{1}{1000}$ was observed, the distance between the two lines was only $\frac{1}{20}$ in.

The results regarding olive oil, lard oil, mineral grease, and sperm oil as applied by baths, were obtained in this way.

Owing to these experiments showing that the moment of friction was much more nearly constant than the coefficient, it was resolved to alter the method of observation, and to measure the moment directly instead of the coefficient. For this purpose the paper cylinder was removed, and a small lever, M (see Fig. 2), was connected to the main indicating lever, in such a manner that the motion of the end of the main lever was magnified five times at the end of the small lever. The end of the small lever was pointed; and when the machine was working this point was brought exactly opposite a fixed mark by putting weights into a scale-pan on the end of the main lever. The main lever was so overbalanced that under all circumstances some weight was required to be added to the scale-pan, in order to bring the end of the small lever to the mark, even when, the friction being greatest, the direction of motion of the journal tended most to depress it. The method of running in both directions, and loading and unloading, was followed as before. The weights in the scale-pan being noted, the moment of friction was given by half the difference between the weight in the scale-pan when running in one direction and in the other.

Experiment showed that the friction varied considerably with temperature. All the oil-bath experiments were therefore taken at a nearly uniform temperature of 90 deg.; the variation above or below this temperature was never allowed to be more than 1½ deg.

III. *Results of Experiments.*—In the earlier experiments care was taken not to load the bearing up to seizing, in order that the condition of the brass might not be disturbed.

In the later experiments the bearing was intentionally loaded up to seizing.

Two sets of experiments were specially made for the purpose of ascertaining the greatest load which could be carried with rape and mineral oil in the oil-bath. The greatest load carried with the rape oil was 573 lb. per square inch, and the greatest load carried with the mineral oil 625 lb. In both of these cases the experiment was repeated after the brass had been taken out and scraped up, but with no better result.

The general results of the oil-bath experiments may be described as follows. The absolute friction, that is, the actual tangential force per square inch of bearing, required to resist the tendency of the brass to go round with the journal, is nearly a constant under all loads, within ordinary working limits. Most certainly it does not increase in direct proportion to the load, as it should do according to the ordinary theory of solid friction. The ordinary theory of solid friction is that it varies in direct proportion to the load; that it is independent of the extent of surface; and that it tends to diminish with an increase of velocity beyond a certain limit. The theory of liquid friction, on the other hand, is that it is independent of the pressure per unit of surface, is directly dependent on the extent of surface, and increases as the square of the velocity. The results of these experiments seem to show that the friction of a perfectly lubricated journal follows the laws of liquid friction much more closely than those of solid friction. They show that under these circumstances the friction is nearly independent of the pressure per square inch, and that it increases with the velocity, though a rate not nearly so rapid as the square of the velocity.

The experiments on friction, at different temperatures, indicate a very great diminution in the friction as the temperature rises. Thus, in the case of lard oil, taking a speed of 450 revolutions per minute, the coefficient of friction at a temperature of 120 deg. is only one-third of what it was at a temperature of 60 deg.

A very interesting discovery was made when the oil-bath experiments were on the point of completion. The experiments being carried on were those on mineral oil, and the bearing having seized with 625 lb. per square inch, the brass was taken out and examined, and the experiment repeated. While the brass was out the opportunity was taken to drill a ½ in. hole for an ordinary lubricator through the cast-iron cap and the brass. On the machine being put together again and started with the oil in the bath, oil was observed to rise in the hole which had been drilled for the lubricator. The oil flowing over the top of the cap making a mess, an attempt was made to plug up the hole, first with a cork and then with a wooden plug. When the machine was started, the plug was slowly forced out by the oil in a way which showed that it was acted on by a considerable pressure. A pressure gauge was screwed into the hole, and on the machine being started the pressure, as indicated by the gauge, gradually rose to above 200 lb. per square inch. The gauge was only graduated up to 200 lb., and the pointer went beyond the highest graduation. The mean load on the horizontal section of the journal was only 100 lb. per square inch. This experiment showed conclusively that the brass was actually floating on a film of

* Adopted by the Committee on Friction, and Presented to the Council of the Institution of Mechanical Engineers, September 28, 1883.

oil, subject to a pressure due to the load. The pressure in the middle of the brass was more than double the mean pressure. No doubt if there had been a number of pressure gauges connected to various parts of the brass, they would have shown that the pressure was highest in the middle and diminished to nothing toward the edges of the brass.

The experiments with ordinary lubrication were begun with a needle lubricator, the hole from which penetrated to the center of the brass. A groove in the middle of the brass, and parallel to the axis of the journal, extended nearly to the ends of the bearing for distributing the oil (see Figs. 5 and 7). It was found that with this arrangement the bearing would not run cool when loaded with only 100 lb. per square inch; and that not a drop of oil would go down, even when the needle lubricator was removed and the hole filled completely with oil, thus giving a head of 7 in. of oil to force it into the brass. It appeared as though the hole and groove, being in the center of pressure of the brass, allowed the supporting oil film to escape. This view was confirmed by the following experiment. The oil hole being filled up to the top, the weight was eased off the journal for an instant. This allowed the oil to sink down in the hole and lubricate the journal; but immediately the load was again allowed to press on the journal the oil rose in the hole to its former level, and the journal became dry, thus showing that this arrangement of hole and groove, instead of being a means of lubricating the journal, was a most effectual one for collecting and removing all oil from it. It should be mentioned that care was taken to chamfer the edges of the groove, so as to prevent any scraping action between them and the journal.

As the center of the brass was obviously the wrong place to introduce the oil, it was resolved to try to introduce it at the sides. Accordingly the center hole and groove were filled up, and two grooves were made. These grooves were parallel to the axis of the journal, extending nearly to the ends of the brass, and were placed at equal distances on either side of the center; they formed boundaries to an arc of contact, the chord of which was 3¼ in. (see Figs. 6 and 8). With this arrangement of groove the lubrication appeared to be satisfactory, the oil going down into the journal and the bearing running cool. The bearing nevertheless seized with an actual load of only 380 lb. per square inch.

The arrangement of grooves was then altered to that usual in locomotive axle-boxes (see Figs. 10, 11, and 12). The oil was introduced through two holes, one near each end of the brass, and each connected to a curved groove; the two curved groves nearly inclosing an oval-shaped space in the center of the brass. At the same time the arc of contact was reduced till its chord was only 2¼ in. This brass refused to take its oil or run cool. It would sometimes run for a short time with an actual load of 178 lb. per square inch, but rapidly heated on the slightest increase of the load. The brass having been a good deal cut about by altering and filling up grooves, it was considered desirable to have a new brass, and one was accordingly obtained. The grooves being made exactly the same as in the last experiment with the old one, this brass seized with an actual load of only about 200 lb. per square inch. The oil box was completely cut away so as to allow a freer current of air round the bearing, and the lubricator pipes were soldered into the brass. The wicks were taken out of the lubricators and the lubricators filled full of oil, by which means oil was supplied to the brass under a full head of 9 in.; and yet the oil refused to go down, and the under side of the journal felt perfectly dry to the hand, and speedily heated with a load of only 200 lb. per square inch.

The fact that this arrangement of grooves, which is found to answer in the axles of railway vehicles, was found to be perfectly useless in this apparatus can only be accounted for by the fact that a railway axle has a continual end play while running, which prevents the brass becoming the perfect oil-tight fit which it became in this apparatus. The attempts to make this arrangement of lubrication answer were not abandoned until after repeated trials. It now became clear that there was no use in trying to introduce the oil directly to the part of the brass against which the pressure acted, and that the only way to proceed was to oil the lower side of the journal, and trust to the oil being carried around by the journal to the seat of the pressure.

The grooves and holes in the brass were accordingly filled up and an oily pad, contained in a tin box full of rape oil, was placed under the journal, so that the journal rubbed against it in turning. The pad was only supplied with oil by capillary attraction from the oil in the box, and the supply of oil to the journal was thus very small; the oiliness in fact was only just perceptible to the touch, but it was evenly and uniformly distributed over the whole journal.

The bearing fairly carried 551 lb. per square inch, and three observations were obtained with 528 lb., but the bearing was on the point of seizing and did seize after running a few minutes with this load. It will be observed that in this instance the bearing seized with very nearly the same load as it did in the oil bath experiment with rape oil.

These experiments with the oily pad show a nearer approach to the ordinarily received laws of solid friction than any of the others. The coefficient is approximately constant, and may be stated as about $\frac{1}{100}$ on an average. There does not in this case appear to be any well-defined variation of friction with variations of speed, according to any regular law.

The results of the experiments with the rape oil, fed by a siphon lubricator to side grooves, follow nearly the same law as the results obtained from the oil-bath experiments, as far as the approximate constancy of the moment of friction is concerned; but the amount of the friction is about four times the amount in the oil-bath.

The results of the experiments on what is called ordinary lubrication, that is, lubrication by means other than that of the oil-bath, were not, as a subject, sufficiently regular to make them worthy of record. Indeed, the results, generally speaking, were so uncertain and irregular that they may be summed up in a few words. The friction depends on the quantity and uniformity of distribution of the oil, and may be anything between the oil-bath results and seizing, according to the perfection or imperfection of the lubrication. The lubrication may be so small as to give a coefficient of $\frac{1}{100}$, but it appeared as though it could not be diminished and the friction increased much beyond this point without imminent risk of heating and seizing. The oil bath probably represents the most perfect possible lubrication, and the limit beyond which friction cannot be reduced by lubrication; and the experiments show that with speeds of from 100 ft. to 200 ft. per minute, by properly proportioning the bearing surface to the load, it is possible to reduce the coefficient of friction as low as $\frac{1}{1000}$. A coefficient of $\frac{1}{500}$ is easily attainable, and probably is frequently attained, in ordinary engine bearings in which the direction of the force is rapidly alternating, and the oil given an opportunity to get between the surfaces, while the duration of the force in one direction is not sufficient to allow time for the oil film to be squeezed out. The extent to which the friction depends on the quantity of the lubrication is shown in a remarkable manner in Table I., which proves that the lubrication can be so diminished that the friction is seven times greater than it was in the oil bath, and yet that the bearing will run without seizing.

Observations of the behavior of the apparatus gave reasons to believe that with perfect lubrication the speed of minimum friction was from 100 ft. to 150 ft. per minute; and that this speed of minimum friction tended to be higher with an increase of load, and also with less perfect lubrication. By the speed of minimum friction is meant that speed in approaching which, from rest, the friction diminishes, and above which the friction increases.

TABLE I.—*Comparison of the Friction with the different Methods of Lubrication, under as nearly as possible the same Circumstances.—Lubricant Rape Oil, Speed 150 Revolutions per minute.*

| | Actual Load, Pounds per Square Inch. | Coefficient of Friction. | Comparative Friction. |
|---|---|---|---|
| Oil bath | 263 | 0·00139 | 1·00 |
| Siphon lubricator | 252 | 0·00980 | 7·06 |
| Pad under journal | 272 | 0·00900 | 6·48 |

TABLE II.—*Comparison of the Friction with the Various Lubricants tried, under as nearly as possible the same Circumstances. Temperature 90 deg., Lubrication by Oil Bath.*

| Lubricant. | Mean resistance, lb. |
|---|---|
| Sperm oil | 0·484 |
| Rape oil | 0·512 |
| Mineral oil | 0·623 |
| Lard oil | 0·652 |
| Olive oil | 0·654 |
| Mineral grease | 1·048 |

N.B.—The above figures are the means of the actual frictional resistances at the surface of the journal per square inch of bearing, at a speed of 300 revolutions per minute, with all nominal loads from 100 lb. per square inch up to 310 pounds per square inch.

They also represent the relative thickness or body of the various oils, and also in their order, though perhaps not exactly in their numerical proportions, their relative weight carrying power. Thus sperm oil, which has the highest lubricating power, has the least weight-carrying power; and though the best oil for light loads, would be inferior to the thicker oils if heavy pressures or high temperatures were to be encountered.

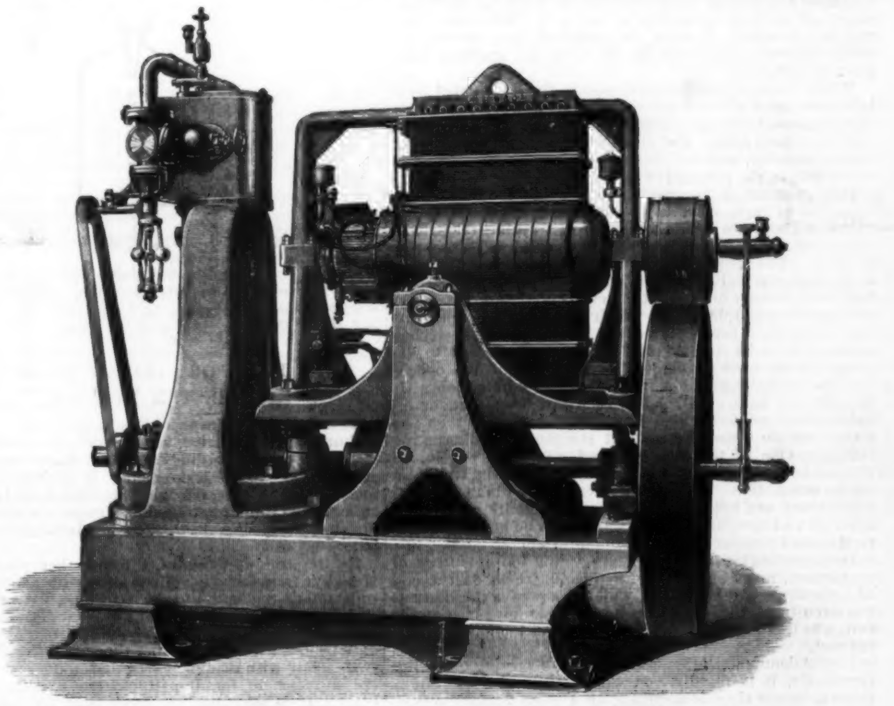
## SIEMENS' DYNAMO.

CONSIDERED mechanically, a dynamo-electric machine is an exceedingly simple appliance, and one which at first sight would appear to present no difficulties in driving. It is true that it usually runs at a high speed, but quick running machines are no rarity, and there are ample stores of experience to draw upon as to the best means of transmission to be adopted. In the days when each generator fed one arc lamp, and consumed from two to four horse power only, the matter was simple enough, but as the number of lamps supplied from one source increased, the subject developed a more difficult and less familiar phase. Belts had now to be made wider and driving pulleys larger, while countershafts had to be driven at higher speeds and furnished with pulleys of unusual diameter. As the incandescence lamp gained ground another stage was reached, for whereas with arc lamps the maximum power absorbed by one generator seldom exceeded 20 horse power, now it often reaches as much as 40 or 50, exceptionally double that, and at an electric light exhibition the bewildered visitor has a difficulty in finding the dynamos among the concourse of boilers, engines, pulleys, and belts which entirely overshadow them. So long as there is ample space at disposal there is no great objection to be made to this; machines running at 600 to 700 revolutions per minute cannot well be driven directly, and belts are probably the best, certainly the best understood means of transmitting the power to them. But unfortunately the requisite space is not always to be had; electric lighting is usually regarded as an adjunct which can be stowed away in a corner, generally in a vault or a small outbuilding, where it is impossible to employ a belt of sufficient length to run well, and then follow the mishaps which have so often brought discredit upon the new illuminant.

But however cramped may be the space allotted to the electrician on land, it is always much larger than that within which he is confined when he undertakes the lighting of an ocean steamship. In a corner partitioned off from a coal bunker, he is expected to erect duplicate engines and plant for 500 incandescence lamps, and he often finds the problem very difficult of solution. He has to provide accommodation for two engines, each capable of indicating 60 or 70 horse power, and for two dynamos, while each engine must be so arranged that it will drive either generator, so that the chances of a breakdown may be reduced to the smallest amount. Arguing from the advantages offered by the electric light engineers to shipowners, it would be reasonable to expect that they should have a fairer chance of doing themselves justice. But the question of space can be settled on theoretical grounds; the exigencies of trade demand that the machinery shall be contained within the smallest possible compass, and it is expected that the ingenuity of engineers will find a means of fulfilling this condition.

Some time ago we illustrated and described a method of rope transmission for driving dynamo machines on board ship, devised by Mr. J. S. Raworth, of Manchester. At the date of our article he had already applied it, on behalf of Messrs. Siemens Brothers, in twenty-three instances, of which the first was on board the City of Rome; since that time the number has been further increased, and in every case the ropes have given perfect satisfaction, showing no tendency to slip, and requiring but little supervision. The growing size of marine installations is now, however, encroaching upon the small area required even for the rope transmission, and Mr. Raworth has invented a new method of driving, which we illustrate above, and which will, we think, from its novelty and originality, interest many of our readers besides those professionally connected with electric lighting. The system adopted, that of frictional or rolling contact, is of course perfectly well known, but hitherto it has never been applied to driving electric generators nor, as we think, for transmitting so much as 40 horse power. The difficulty in the application lay in the necessity of avoiding a great strain upon the bearings of the dynamo. The armature runs so closely to the field magnets that any considerable wear in the bearings brings about the destruction of the former, and since the contact between the rolling surfaces is theoretically only a line, it was feared that there must be a heavy pressure brought to bear upon them to gain the required adhesion, and that it would be dangerous to transmit it through the bearings. To avoid this the generator is mounted on a cradle carried in trunnions, so that it is perfectly free to swing in a vertical plane fore and aft, and so accommodate itself to any position of the driving pulley, the stress in the bearings being only that due to the weight of the armature, and the turning moment required to drive it far less than that to which it is subjected when driven by a belt or by a rope.

The pulley on the armature spindle is composed of disks of paper powerfully compressed between two wrought iron cheeks, and turned to a smooth cylindrical surface. It runs in contact with a large cast iron pulley, which is also the flywheel of the engine, and the two are maintained in intimate connection by a pair of tightening bars. The armature spindle and flywheel shaft are each turned down at the end and run in gun metal sleeves provided with wings or lugs for the passage of these bars. At the lower end, each bar has a head, and at the upper end it is screwed to receive a milled hand nut with a head 2 inches in diameter. Under each nut is a short helical spring about 1 inch in length, so that as the nuts are screwed down the strain is gradually increased. As a matter of fact the pressure required to keep the two rolling surfaces in working contact is exceedingly slight, two or three turns of the nuts, made only by the thumb and finger without any lever or screw key, being amply sufficient for



SIEMENS' DYNAMO WITH FRICTION DRIVING GEAR.

the purpose. The engraving represents a Siemens S D$_5$ dynamo, designed to feed 200 Swan lamps and a six horse power Tangye engine, controlled by a Pickering governor.

The first machines driven in this manner fed 60 lamps, and were placed on board the steamship Aurania, where they have answered admirably. There is one machine upon the City of Chicago and two upon the Massilia, of the Peninsular and Oriental service, and gradually increasing sizes, up to the largest constructed by Messrs. Siemens Brothers, are now being adapted to this method of driving with very successful results. When duplicate dynamos are installed, a pair of engines are placed in the center of the bed with a generator at each side. The engines are not usually coupled together, but should one engine and the opposite dynamo both fail, then the two crankshafts can be coupled together to transmit the power from the remaining engine to the other generator. Our engraving represents one of five apparatus exhibited before the British Association at Southport.—*Engineering.*

## METHOD FOR RAPID DEMAGNETIZATION.*

By JOHN TROWBRIDGE and WALTER N. HILL.

IN connection with our investigations on the heat produced in iron and steel by reversals of magnetization, it may be interesting to refer to some experiments made by Lt.-Comm. A. G. Caldwell, U.S.N., and ourselves, on demagnetization. These experiments were made in 1880, but have not been published.

Perfect demagnetization, or entire absence of magnetism in a mass capable of magnetism, is a condition of great rarity. Approximate demagnetization has been brought about with some difficulty, but delicate tests would show traces of polarity.

We have, however, discovered a method by which complete demagnetization may be rapidly and easily produced. The principle involved is the setting up of a state of powerful magnetic vibration, by which all previous magnetic conditions are obliterated and on the subsidence of which no polarity remains. This state of vibration is induced by an alternating current of *sufficient strength.* By this an effect is induced in the magnetized mass which can only be compared to a vibration or wave. The reversals of the inducing current cause corresponding reversals of polarity in the body acted on, and as these reversals are continuous and very rapid (5,000 to 6,000 per minute, for example), a molecular vibration probably arises. It is probable that a condition of strain or set is one of the phenomena of magnetism.

The particles have been made to assume a certain definite or polar relation or position. When, however, a powerful movement or vibration is caused, it is evident that when this vibration has become complete—that is, involving the whole mass—all previous conditions of strain or "permanent set" will be overcome. It must be remarked that, in order to perfectly attain this result in all cases, the exciting force must be sufficient.

When the alternating current ceases, the body acted on is left perfectly free from polarity. It is, however, in a state of extreme sensitiveness, and must be allowed to remain at rest for a short time. If it is placed north and south, it will assume polarity, and very strongly, if struck with a hammer when held in the position of the dip.

Demagnetization requires but a short time in most cases—from one to three minutes if the current is properly adjusted. There are several ways of performing the experiment, but it will be sufficient at this time to refer to a few of them. The most effective method is to inclose the mass to be demagnetized in a coil of such a length that the whole body will occupy an approximately central position. The coil may be a simple one, in which case it must stand east and west, and before removing the object the electric machine must be stopped, and the current allowed to die away. Also, when the object is taken out of the coil, it must be carefully shielded from the earth's induction. Or the coil may be so constructed that it can be opened or divided at the center without breaking circuit, and then the object can be taken out without stopping the alternating current. One of the coils we used was made of No. 12 copper wire, wound as one coil, but in halves, with an elastic connection. It is well known that, with an alternating current, self-induction in the coil materially reduces the current, and therefore the coil should be one of a comparatively small number of turns.

Demagnetization of small masses, not too retentive of magnetism, may be performed by placing them on the end of a bar contained in the coil, which is a part of the alternating circuit. A bar of low steel, somewhat longer than the coil, was used, and the small objects placed on its projecting end.

*Perfect* demagnetization is attained with varying difficulty. Ordinarily, it is rapidly and easily accomplished. Sometimes a longer time is required, or a more intense action. In numerous experiments, we derived the alternating current from a Wilde machine which gave about 6,000 reversals per minute. This rate is probably greater than is required or desirable, except in extreme cases. About 3,000 to 4,000 reversals would be a better general rate, although of course the operator should arrange his apparatus so that he could get more reversals if necessary. Failure will result if the speed is too great, as might be expected if the view here taken is correct. Usually, it will be more convenient to employ, instead of an alternating machine, a battery with a reverser arranged for varying speeds.

One application of this method is to the demagnetization of watches. Watches strongly magnetized are completely demagnetized by one to three minutes' exposure in the coil. Frequently unsuspected traces of magnetism cause annoying irregularity of action of a watch. This method enables us entirely to remove this difficulty.

Some very curious and interesting results were obtained by experimenting with magnetite.

A specimen of very pure magnetite, from North Carolina, showing marked magnetic properties, was completely demagnetized by a somewhat long exposure to the action of an alternating current applied as described above. Before demagnetization the piece had shown consequent points, although in general it possessed polarity. After treatment it attracted either end of a very light suspended needle indifferently, and when any part of the mineral was presented, just as a piece of soft iron would do. The demagnetized specimen was then placed across the poles of an electromagnet excited by a strong current from a Gramme machine. It became strongly magnetic, with distinct poles, and without the consequent points it at first had. After this it was treated like an ordinary bar magnet, and magnetized or demagnetized at will.

Another more impure piece was originally less strongly magnetic, and was demagnetized with great difficulty. At first it displayed no general polarity, having consequent points irregularly distributed. After demagnetization it received induced magnetism and became polar, but it was a much feebler magnet than the previous specimen. Demagnetization was afterward performed more easily than at first.

A still more impure specimen was treated, but with the means at hand it was not *perfectly* demagnetized, although so nearly was this done that only traces of magnetism were noticeable.

The results of our work can be stated as follows:

1. The heat developed by reversals of magnetization is probably due to induction currents, and not to molecular vibrations; for considerable changes in the molecular structure of different specimens of iron and steel fail to show differences in the amount of heat developed.

2. The heating of iron cores of electro-magnets, which are submitted to alternating currents, is confined to the surface until conduction equalizes the heat of the cores.

3. The musical note emitted by the core is the note of the coil, due to the number of reversals of the machine, and is merely strengthened by the metallic core of the electromagnet. This note should not, therefore, be used as an argument in favor of molecular vibrations of magnetic particles.

4. Experiments on demagnetization confirm what has long been known in regard to the effect of vibrations and shocks upon the magnetic condition of iron and steel. They do not invalidate our results upon the heat produced by reversals of magnetization; for a very slight change in position of the molecules might affect the magnetism of a bar, and yet be insufficient to produce the great heating observed in the armatures of dynamo-electric machines.

* Contributions from the Physical Laboratory of Harvard College.

## A SIMPLE RAIN GAUGE.

LET the tinsmith make a funnel with a small—say one-quarter inch—opening at bottom, and having a two-inch band soldered round the top as shown in sketch, to prevent the rain that falls within it splashing out again. The upper edge of this band must measure an exact 8 inches in diameter. Take a good large bottle—an ordinary wine bottle will serve, but in localities where the rainfall is heavy something larger is preferable—into this bottle measure 3½ fluid ounces, and mark the bottle at the water level; so on


till the bottle is filled, marking the water level of each added measure of 3½ ounces.

Each of these graduations shows one-eighth inch of rainfall. For convenient reference the graduations may be marked on a strip of paper and gummed outside the bottle.—*J. W. F. Stockton, Min. and Sci. Press.*

## PIURI, OR "INDIAN YELLOW."

By T. N. MUKHARJI.

THE India-office furnishes the following:

Piuri is a yellow dye, used chiefly in painting walls of houses, doors, and railings. It is seldom used for dyeing cloth, owing to its bad smell. It is derived from two sources—(1) of mineral origin, imported from London; (2) of animal origin, manufactured at Monghyr, a town in Bengal. Sir Joseph Hooker has asked for information about the latter.

By inquiries in Calcutta, I found that piuri is made at Monghyr from the urine of cows fed with mango leaves. To substantiate the truth of this statement, I went to Monghyr, and there found that a sect of gwalas (milkmen), residing at a place called Mirzapur in the suburbs of the town, are the only people who manufacture the substance. They feed the cows solely with mango leaves and water, which increases the bile pigment, and imparts to the urine a bright yellow color. It is said that the cows thus fed die within two years, but the piuri manufacturers assured me that this statement is wrong; and, indeed, I myself saw cows six or seven years old from which piuri has been obtained during the last four years. The cows, however, looked very unhealthy, and the manufacturers of piuri told me that, to keep up the strength of the animal, they now and then allow her grass and other fodder besides the mango leaf, but a mixed food reduces the proportion of the coloring principle in the urine. Owing to the injurious effect which the treatment necessary for the manufacture of piuri has on the cows, the occupation of making piuri is confined to a very small number of people, who for this reason are looked down upon by their fellow caste-men. I am told that in no other part of the country is the manufacture of piuri carried on. The cows treated with mango leaves are made to pass urine three or four times a day by having the urinary organ slightly rubbed with the hand, and they are so habituated to this process that they have become incapable of passing water of their own accord. The urine is collected during the whole day in small earthen pots, and in the evening put over a fire in an earthen vessel. The heat causes the yellow principle to precipitate, separating it from the watery portion. It is then strained with a small piece of cloth; the sediment is made into a ball, and dried first on charcoal fire and then in the sun, when it is ready for the market. The merchants, chiefly Marwaries, who advance money to the milkmen for the purpose, purchase the stuff at R. 1 (1s. 8d.) per lb., and export it to Calcutta on the one side and Patna on the other. The price of the imported mineral piuri is only 4d. per lb. The animal piuri is of an exceedingly bright color, and is, therefore, considered very superior to the mineral piuri. The high price of the animal piuri is probably owing to the deterioration of the live stock consequent on the manufacture of the article, and the cost of procuring mango leaves, which are sold at the rate of Rs. 2 for the produce of a middle-sized tree, say thirty feet high. An average cow passes about three quarts of urine per day, which yields about two ounces of piuri. The animal supply is said to be about 100 to 150 cwts.; but this seems to be an overestimate, considering the small number of cows employed for this purpose.

I myself saw mango leaves lying before the cows, the collection of urine, and the manufacture of piuri. So the real source of this kind of piuri is now beyond any doubt whatever.

I have sent to Sir Joseph Hooker direct—(1) The mineral piuri brought to Calcutta from London; (2) Monghyr piuri purchased at Calcutta; (3) Monghyr piuri purchased from the manufacturer; (4) a bottle of urine from which the piuri is obtained; (5) an earthen pot in which the urine is collected; (6) quantity of the mango leaves.

27th August, 1883.

## PEAT AS A GAS-MAKING MATERIAL.

AN interesting article on peat and its utilization recently appeared in the *Organe Industriel de l'Eclairage* (the Belgian gas journal), from which the following abstract has been compiled. The question of utilizing peat in place of coal has been very seriously studied in France and the Low Countries, as they were formerly called, in consequence of the occurrence of immense deposits of the material in these regions, and the comparative inferiority of the native coal. Peat may be described as a kind of coal of recent formation, containing much water and earthy impurities, which is capable of producing gas more or less freely; the crude gas containing an almost unmanageable quantity of carbonic acid. The article now under notice has apparently been written with the object of calling attention once more to the potentialities of peat for gas-making and other purposes. It must be confessed that the subject is almost hopeless; for many inventive geniuses have been discouraged and much money wasted in attempts to prepare peat fuel for general use in gas-works and factories.

Subjected to distillation, peat gives a gas burning with feeble light, and an oily liquid from which a gas said to be four or five times more brilliant than coal gas is extracted. The mixture of these two gases give a light equal to about three-fifths that of coal gas burnt under the same conditions. MM. Recce and Peigne-Delacour have sought to utilize the residual products of peat—such as the tars—from which may be extracted liquid hydrocarbons suitable for lighting, paraffin, wood spirit, and sulphate of ammonia. Peat begins to distill at 109° C., producing very little sulphureted hydrogen. The liquor distilled over contains acetic and butyric acid and creosote. The production of tar is from 6 to 9 per cent. The residuum of the retorts contains about 6 or 8 per cent. of ash; and being sufficiently compact, makes a useful fuel. When the coke or charcoal is powdery, it possesses in a very high degree the property of absorbing ammonia, and therefore it serves for the preparation of manure. For this purpose the charcoal is saturated with ammonia, and mixed with ashes of schists rich in sulphates and phosphates. Sometimes the peat ashes are used without admixture of anything else, for lightening and improving soils.

Peat is worked in 31 departments of France. In 1880 the men engaged in this industry numbered 28,600; and 240,000 tonnes were produced from 867 pits. A capital of three million francs is represented by this working. Besides its use in blocks, as a fuel, and in the form of coke, peat has been made to yield other products in the following proportions per 1,000 parts of the raw material:

| | Kilos. |
|---|---|
| Charcoal | 200 |
| Small coke | 100 |
| Grain charcoal | 50 |
| Dust | 50 |
| Ammoniacal liquor | 350 |
| Benzene | 4 |
| Illuminating oil | 6 |
| Lubricating oil | 22 |
| Coloring bases | 5 |
| Phenic acid and creosote | 6 |
| Paraffin | 2 |
| Carbonaceous residue | 5 |
| Gas and loss | 200 |
| | 1000 |

From this table it appears that peat is rich in essential matters; and it is astonishing to the author of the memoir that since 1878 the general output of this material, capable of being adapted to so many uses, should have diminished rather than increased.

So far the Belgian author, who, it must be admitted, has made out a good case for the utilization of peat. As, however, there is no economical or industrial fact such as that mentioned in regard to the diminished use of peat, without its proper and sufficient explanation, the writer might have usefully concluded his remarks by offering his own views of the explanation in this case. As he has not done so, and lest it should be thought that the trade in peat is unduly suffering neglect at the hands of gas manufacturers and other large users of fuel, we will endeavor to supply the omission. In the first place it may be pointed out that the author himself admits that all the gas obtainable from peat by a double distillation is at best only three-fifths as good as coal gas produced at one heat. It is much to be feared that all the usable residual charcoal—which weighs altogether very little more than the gas—would not maintain the retorts at a sufficient heat for distilling such a watery material, even once; to say nothing of the second operation of the same kind. And it must not be forgotten that with the second distillation—in which the whole of the illuminating oils, paraffin, and benzene would be gasified—the value of these residuals would also disappear. If they are turned into gas, it is very evident that they cannot also be realized as residuals. After the coke has been burnt for fuel, and the oily liquids converted into gas, the only real residuals would be some ashes, a little ammoniacal liquor, and some pitch. All the rest, which figures so largely in the Belgian writer's catalogue, would have gone to make a gas 40 per cent. worse than coal gas. One need not look further to understand why peat is not used for gas-making. It is the development of French and Belgian coal mining that has thrown a shadow over the peat industry of the same countries. Peat will always find a considerable local sale for household purposes; but for nothing else, while coal, of even passable quality, can be mined. For the purpose of ascertaining their commercial value, coal and peat may be described as the higher and lower varieties of the same thing. Coal is essentially a very superior peat; and peat is a more or less imperfect and inferior coal. A great proportion of the coal raised in Eastern Europe is not much better than peat, while on the other hand the best peat of Ireland is an immeasurable distance from the worst

coal of Wales or Scotland. To complain that a poor material is rejected in favor of a better, is the most unprofitable grumbling, whatever may be its object. As we have now shown, therefore, the question of most importance in regard to the possible utilization of peat in gas manufacture or the kindred arts is, not whether the raw material contains gas, coke, tar, and the rest of the recited residuals, but simply how much of these, or of any one of them, in comparison with the known capabilities of coal. Examined in this light, it is abundantly evident that the difference between peat and coal, even of degree, are so seriously to the disadvantage of the former, that its use in place of the latter is not within measurable probability.—*Jour. Gas Lighting.*

## THE PREPARATION OF ALUM.

THIS salt, improperly denominated sulphate of alumina in the modern nomenclature, is by far the most important of all those with earthy bases. The earth which forms the base of alum is alumina, which is one of the most extensively diffused in nature, its properties having been familiar to mankind from the earliest antiquity.

The simplest process by which alum is prepared is that in use at the Solfatara, near Naples. It has been described by the Abbe Mazeas and Fougeroux de Bondaroy.

The Solfatara, called by the ancients Forum Vulcani, is a small plain on the top of a hill, covered with a white soil, in which are perceived numerous round holes or craters, from which sulphurous vapors are constantly ascending. The ground, even at the surface, is considerably warm, and at the depth of a very few inches is so hot as to be intolerable to the hand. It is celebrated by Pliny for its sulphur, but the alum establishment is of a much later origin. The white clayey soil of this plain, being penetrated and entirely impregnated by sulphurous vapors, forms a rich ore of alum, as may be ascertained by its strong styptic taste when applied to the tongue. In order to extract the salt, a shed is erected, in the middle of which is placed a large oblong leaden cistern, let into the ground almost up to the brim, in order to receive a proper quantity of the subterranean heat; this cistern is surrounded by smaller caldrons, let into the ground in the same manner. When all is prepared, the extraction of the alum begins by putting some of the aluminous earth into the cistern, and pouring water upon it; this mixture is carefully stirred, till the whole of the salt is dissolved; after which, the earth being removed, a fresh portion is put in, so as to bring the water almost to a state of saturation. The liquor is now removed into the smaller caldrons, and the loss by evaporation is supplied by fresh liquor, till a pellicle begins to appear on the surface. It is then removed into tubs, where, as it cools, it deposits a large quantity of crystals of alum. The mother liquor is returned to the cistern, where it is mixed with earth as before. The crystals of alum are purified by a second solution and crystallization, after which they are fit for the market. Hence it appears that the alum exists ready formed in the earth of the Solfatara, and that the whole of the manufacturing part is reduced merely to lixiviation and purification. This alum, from the careless method of preparing it, is considerably fouled by sulphate of iron. The proportion of alum contained in the ore must of necessity be very various; a specimen, analyzed by Bergman, yielded only eight per cent., whereas the Abbe Mazeas procured, by simple lixiviation, two pounds and a half of crystals from six pounds of the earth, or about forty-one per cent. It is observable that no addition of potash or ammonia is made in this manufacture; the alkali must therefore exist in the ore. As no analysis has been made of this alum, it is impossible to tell which alkali it contains.

The alum works of La Tolfa, near Civita Vecchia, are among the oldest in Europe; and as the alum manufactured here is reckoned the purest of any, we shall give a detailed account of the process, as reported by the Abbe Mazeas and Fougeroux de Bondaroy, to whom we have already been indebted for the preceding particulars.

The ore made use of at La Tolfa is the Alaunstein of the Germans, which is procured about a mile off the place where it is manufactured. It is found in irregular strata, and deep, almost perpendicular veins in the side of a hill; and when unmixed with other substances is of a yellowish white color, and so hard as to require blasting by gunpowder. Being broken into pieces of a moderate size, it is first of all roasted. The furnace made use of for this purpose is a cylindrical cavity in a mass of masonry, the greater part of which is occupied by a hemispherical dome, with a large round aperture in its top. The fuel, which is wood, is conveyed by a side door into the dome, and the alum ore is piled skillfully over the aperture, so as to form a smaller dome, whose diameter is equal to that of the aperture in the lower one. As soon as the fire is kindled, the smoke and flame penetrate through the interstices of the pieces of ore, and quickly heat the whole mass. For the first three or four hours, the smoke escapes in dense volumes, but by degrees it acquires a whiter color, the pieces of ore become of a light red or rose color, and a faint smell of liver of sulphur becomes manifest. At the end of twelve or fourteen hours the fire is extinguished, and when the alum stones are grown cool they are taken down, and again arranged in the same manner as before, only observing to place those pieces near the center of the fire which were before at the sides, that the whole may be equally calcined. The second roasting continues nearly as long as the first, and the stones are considered to have been properly managed if they are of a uniform white color, and considerably styptic when applied to the tongue.

The second process commences by piling the stones upon a smooth sloping floor, in long parallel ridges, between each of which is a trench filled with water; from this trench the beds are frequently sprinkled, in proportion as they become dry by the action of the sun and wind. After a few days the pieces of roasted ore begin to swell and crack, and fall to powder like quicklime when it is slaked, acquiring at the same time a light reddish color; and at the end of forty days, more or less, this operation is completed. Its success is materially influenced by sunshiny weather, the hottest periods of the year producing the best alum, and in the largest proportions, while long continued rains entirely exhaust and spoil the ore.

The next stage of the manufacture consists in dissolving the alum out of the ore, and disposing it to crystallize. For this purpose a leaden boiler is filled two-thirds with water, and portions of the decomposed ore are successively stirred in, till the vessel is nearly full; when the liquor begins to boil it is diligently stirred up from the bottom, that the whole of the alum may be dissolved, and the waste by evaporation is supplied from time to time by the mother water of a preceding crystallization. At the end of about twenty-four hours the fire is extinguished, and the liquor is left at rest for the particles of earth to subside; as soon as this has taken place, a stop-cock, fixed in the side of the boiler, about one-third of its height from the bottom, is opened, and the clear solution is transferred along a wooden spout into square wooden reservoirs, seven feet high by five wide, so constructed as to be readily taken to pieces; in these it remains about a fortnight, during which time the alum crystallizes in irregular masses upon the sides and bottom. The mother liquor is of a flesh color and unctuous appearance, and still rich in alum; it is therefore transferred into shallow receptacles, where it deposits, after a time, both earth and crystals; these latter are taken out and separated from the impurities by washing in the residual fluid. Finally, this fluid itself is let out into a deep reservoir, whence it is pumped, to be mixed with fresh water and earth in the leaden boiler, as already mentioned. The earth, after having been once lixiviated, is thrown away, although by simple boiling with sulphuric acid it may be made to yield a considerable quantity of pure alum.

The uses of alum are various and important. It is an article in the materia medica; it is a necessary ingredient in most kinds of pigments and lake colors, and in the various processes of dyeing. All leather that is not tanned or dressed with oil is prepared for use by means of alum. It is used by candle makers to harden their tallow and make it white; and an unauthorized use is occasionally made of it by bakers in the preparation of the finest white bread.—*Glassware Reporter.*

## BOTTLE GLASS.

THE quality of the glass used in making bottles for aerated and other beverages is of much greater importance than might be supposed. Most bottlers are more particular about the color of their bottles than they are about the quality of the glass, and yet the exact color is of little consequence, provided that the glass is bright and clear. What is required is solid glass, free from "oats," or bubbles. A "seedy" or spongy glass is to be avoided, for it is invariably weak; each "oat" is a bubble which materially diminishes the strength of the glass.

"Winds" on the surface of the glass are also an indication of weakness, and should be avoided. These "winds" are generally evidence that "cullet," or old glass, has been remelted with a portion of new glass, and has not been thoroughly assimilated.

Glass made in pots is more apt to contain "winds" than that made in tanks, from the fact that less "cullet" is used in making the latter. This will be readily understood when the two processes of manufacture are explained.

Pot glass is made as follows: The batch is placed in the pot and melted through the night, being fed as often as required with the batch by the shearer. When melted the glass will sometimes froth considerably, when it requires some time to settle. Sometimes, in the eagerness to commence blowing, the glass is not allowed sufficient time to thoroughly subside, and the result is "seedy" glass. At other times a large amount of salt water will appear over the glass, considerably retarding the melt. In such cases it is usual to fill the pots with broken glass until the salt water has all run over, leaving only glass in the pots. If the original batch had much "cullet" in it already, the addition of more generally causes the "winds" above referred to.

The other method of making glass is to melt the batch in a furnace, feeding it at intervals. The melted glass is carried off in a trough to a tank, and is taken from this tank to be blown. The glass in the tank is fined, and at all times ready to work. It need not, therefore, be "windy."

Of these two processes of making glass, the latter produces the better quality, and, provided the annealing is equally good in both cases, it is safe to say that a bottle made with tank glass will prove more satisfactory than one composed of pot glass.

The hammered look that some bottles present is not a sign of weakness, and is of no consequence except as far as the appearance is concerned. The cause of this "hammered" appearance is that the glass was put into a mould which had not been made sufficiently hot, and the steam from the surface of the mould has imprinted itself on the bottle.

Much could be said about workmanship that would be applicable to all factories. The workmen are not all skillful in a glass factory any more than they are in a machine shop or in any other trade. It often happens that apprentices are allowed to blow bottles when an order has been taken at too low a figure to allow it to be filled profitably by skilled workmen. It is misplaced economy to buy a low-priced bottle of inferior quality, for the loss by breakage will be so great as to more than counterbalance any difference in first cost.—*Earthenware and Glass Trades Chronicle.*

## THE REPEATED BOILING OF HOPS.

By Dr. SCHNEIDER, Director of the Worms Brewers' Academy.

AT the closing exercises of the Brewing Academy at Worms this year (on which occasion about 200 colleagues and interested parties from all parts were present), among other subjects the technical press has frequently referred to, the best method of using hops came up for discussion. As is well known, a short time since a system was recommended in which the hops, after having been once boiled as usual, were boiled with the four or five following brewings. The agents for this new system of hop boiling claimed to obtain not only a better yield, but that a more normal, a more equable, and a better flavored beer was attainable, and they stated that a celebrated expert in brewing, speaking of the new method of boiling hops, said: "Even when no hops are saved by this more complete extraction, every brewer must commend the process, because it is a fact that, subsequently to leaving the kettle, the brewing process becomes notably more regular, more complete, and more normal." We must also remember that the chief brewer in a brewing academy, under the heading "Hop-boiling Method of M. Dienhardt," writes in the *Allgemeine Brauer und Hopfen Zeitung* and in *Gambrinus*, expressing himself favorably on the subject, and that further, Brewer Messerschmidt of Homburg v. d. H., a large brewer, warmly defends the process, and therefore every brewer will consider himself directly interested in this much discussed question. My pupil, Brewmaster Tobler, and myself, in conjunction with our brewery expert, Lorenz Enziger, have consequently discussed the methods of testing the process so far employed, and have together agreed upon a method we have pursued. Respecting the opinions expressed by others I will first refer to an article in the *Schwabische Bierbrauer* dated Munich, in which a saving of 40 per cent. in hops is claimed. Whether and to what extent the analyses made then by Dr. Prior are free from error I will leave to another to decide. For practical purposes they appear to me to be without any value, for a brewer does not extract his hops either with water, with alcohol, or with ether, but with beer worts. This has been done in the case of the experiments conducted by Brewmaster Adolph, but in a manner that does not allow of a satisfactory result being arrived at, for when we add the hops already once used and unused hops together to the worts, and then boil these two quantities of boiled hops with a third quantity of unboiled hops, and then these three samples of hops again with a fourth, etc., it is utterly impossible to determine to what extent the once boiled hops give off valuable substances to the worts when boiled for the second, third, fourth, or fifth time with the latter. Recognizing the uncertainty of these modes of proceeding, we have agreed together on another plan. Whether this is the only correct one remains to be proved, but we consider it the correct method of ascertaining to what extent hops can be exhausted by boiling in beer worts, and what effects the so extracted substances have upon the beer worts. We have employed in our experiments, as was done in the other tests, hops that had been dried and weighed, and have boiled them for two hours in a proportionate quantity of worts. Then we have carefully strained out the hops, drained them, and then steeped them for from 10 to 12 hours in distilled water. A simple rinsing off of the particles of wort adhering to the leaves did not appear to us sufficient, because we found, for instance, that blotting paper dipped in beer worts retained a portion of the worts it absorbed so tenaciously, that a simple rinsing did not suffice to remove it, but that it required a lengthy steeping in distilled water to properly extract it.* The hops so treated we have then thoroughly dried and weighed, and have in this wise ascertained that they had given up 30 per cent. of their substance to the worts during the first ordinary boiling. Then these hops were boiled alone (not according to the Deinhardt process with fresh hops) for another two hours in worts, then again deprived of the worts they had absorbed by prolonged steeping in distilled water, dried, and weighed again, and it was found that they had yielded another 11 per cent. to the worts. The same process was pursued for the third time, and this test showed that hardly 1 per cent. had been yielded up to the worts. We should mention that on the second utilization of the hops an excellent break occurred in the worts, and that both their aroma and flavor were perceptible. The third boiling produced no break, and the flavor and odor were unpleasant. The same experiment was repeated and also my test, in which 5 grammes of hops were boiled in a suitable quantity of wort for two hours, other 5 grammes three hours, other 5 grammes four hours. The hop residues in each case were steeped to remove worts, dried, and weighed, and in this manner the extent to which they had been exhausted by different periods of boiling ascertained. The results were:

| | |
|---|---|
| Two hours' boiling | 33 per cent. |
| Three " | 39 " |
| Four " | 41 " |

As these experiments of Mr. Tober's, who since vacation has been appointed brewmaster in Havre, only resulted in showing the extent to which hops could be exhausted by different periods of boiling, it was noticeable that the worts boiled with hops for four hours were less pleasant than such as had only been boiled two hours. From these experiments we have only ascertained what old and experienced brewers have long known, *i. e.*, that according to the prevailing methods of boiling hops, valuable material is left in them, and that where in addition to the heavy lager beer a light beer is brewed, they can be used a second time to advantage. But to boil hops three, four, or five times ranks with the grossest errors that can be committed in brewing. I hope that no one, not even my opponents, will see in this treatise anything but good will on my part and a desire to treat a burning question in brewing circles in a practical manner. As, however, there remain thorough practical brewers and brewery owners who are widely respected, as well as technical brewing institutes, that have interested themselves in the subject, I felt myself impelled to treat the subject as it is in a thorough manner. I may probably expect to have my opinions attacked, but I believe that sensible men will themselves seek the truth. If they lack the apparatus to accomplish the foregoing experiments, they can doubtless find a friendly apothecary who will assist them to make them as well as we did, or perhaps better; and so lead them to the truth. For the rest, I never expected to obtain results different to those we found. These experiments prove by satisfactory methods that the process of boiling the same hops for the fourth or fifth time has been founded on erroneous methods of experimenting; and though it would appear, in spite of these facts, that several brewers have attained good results with the process, still it is a mistake, for capital, labor, and the risk to the beer are never in true proportion to the profits gained even by using the hops only for the second time.—*Gambrinus; Brewers' Guardian.*

## AN EASY METHOD OF INTENSIFICATION FOR WET PLATE NEGATIVES OF LINE ENGRAVINGS.

WM. BROOKS in the *British Journal of Photo.* says: Take the negative of the engraving to be copied in the ordinary way with wet collodion and the nitrate of silver bath, taking care not to overexpose, but give it sufficient exposure to preserve clear glass to represent the black lines. After it is fully out with the ordinary iron developer of the usual strength, say—

| | |
|---|---|
| Protosulphate of iron | 15 grains. |
| Glacial acetic acid | 15 minims. |
| Water | 1 ounce. |

well wash and intensify with the ordinary pyro intensifier, namely—

| | |
|---|---|
| Pyrogallic acid | 2 grains. |
| Citric acid | 1 grain. |
| Water | 1 ounce. |

Just get a little intensity, but do not push for it; fix with cyanide of potassium (not hypo.); well wash and put into a bath of—

| | |
|---|---|
| Bichloride of platinum | 4 grains. |
| Nitric acid | 1 drop. |
| Water | 10 ounces. |

Keep the dish slightly rocking to get even action over the whole film; allow it to remain until the film is black, which will be in about two or three minutes, and it will be noticed, should there have been any *slight* veil on the lines in this bath, they will have cleared and brightened up. It

* To prevent any possibility of a mistake, it should be added that the distilled water in which the hops were steeped was found to contain nearly 2 per cent. of extract, the saccharometer showing 1·5 per cent.

is very curious that it should have this effect, but it has. On taking it out of the bath, if it were fairly dense to start with, it will have increased in density on looking through it, and will be of a slate color. If it have only been a ghost of an image at starting, the image would almost have disappeared in this bath. Unless there was a certain amount of intensity, this is sure to occur.

Well wash the plate and proceed to intensify with pyro. and silver as before. It will be found to increase very rapidly in intensity, and the lines will keep remarkably clear. There is no fear of their blocking up after a certain amount of intensity is obtained; when it appears difficult to get any more, wash it and place it in the platinum bath as before for about the same time. On looking at it the plate will be found to have gained considerably in intensity and to have become much blacker. After washing it, it can be treated with pyro. and silver again, or as many times as may suffice to produce the requisite amount of density.

One thing must be guarded against, namely, not to force it too much with pyro. and silver; that is, not to allow the pyro, to act on the film after intensity apparently ceases, as it will readily be gained after further treatment with the platinum bath. If this be attended to, there is not the slightest fear of the film splitting up or drying. There is one precaution I take to keep the film from washing up, and that is to edge the plate with India-rubber solution.

I must not omit to mention that the platinum bath may be strengthened from a stock solution kept for that purpose. My stock solution is as follows:

| | |
|---|---|
| Bichloride of platinum................. | 60 grains. |
| Water.............. .............. | 10 ounces. |

Before I discarded wet collodion for field work I found this system exceedingly useful when the light was very dull in winter weather, when, occasionally, I used to get a thin negative.

The use of platinum is far better than the old iodide in water to flood the plate with, followed with pyro. and silver. To those who have any line work to do my advice is to try it.

## NOVEL METHOD OF LOCALLY INTENSIFYING AND REDUCING GELATINE NEGATIVES.

By HERR ECKERT.

WHEN the negative was quite dry, but unvarnished, he went over all the parts that were sufficiently powerful with a coating of asphalt varnish, taking care to follow the outline as nearly as possible. This varnish should not be used too thick, otherwise the coat would be patchy, owing to the varnish not flowing; nor yet should it be too thin, else it would be apt to overflow the outlines. When laid in a warm place this varnish should dry in about a couple of hours, after which the negative may be intensified as much as it requires in the usual way, the effect of the intensification now only extending to those parts which are not covered by asphalt varnish. After being carefully washed and dried the asphalt varnish may be removed by means of a rag of cotton wool dipped in benzine, and then the further treatment of the negative proceeded with as usual.

Of course the reduction of negatives is effected by covering those parts which are weak with the asphalt varnish, and leaving the over-powerful parts exposed. When thus doctored many a negative will furnish brilliant instead of only middling-good prints, and the effects of too harsh contrasts of light and shade may easily be overcome.

## ON THE PRESSURE OF THE VAPOR OF MERCURY AT THE ORDINARY TEMPERATURE.*

By Professor McLEOD.

AT the last meeting of the Association Lord Rayleigh called attention to a paper that had appeared in the *Annalen der Physik und Chemie* (N. F., xvi., 610), by Hagen, on the pressure of saturated mercury vapor at low temperatures. The pressures given for the ordinary atmospheric temperatures, although considerably less than those published by Regnault, appeared rather higher than some recent observations seemed to warrant. A method of determining the vapor pressure at ordinary temperatures seems to have occurred to Mr. Crookes and myself almost simultaneously, and I much regret that his absence from the present meeting prevents us from learning the results of his work. Mr. Crookes intended to try the experiment *in vacuo*, whereas I thought of saturating air with mercury vapor; but we both intended to determine the quantity of evaporated mercury by a chemical test.

A glass flask of about 1·9 liters capacity was employed for the experiment, and within it was supported, by a piece of string, a glass tube 14 mm. in diameter, and filled with freshly-distilled mercury, the flask being closed by a greased glass plate. After standing at the temperature of the laboratory for about nine days, the mercury tube was removed, and a small quantity of boiling nitric acid poured into the flask and left to stand for some time. The acid was next neutralized by ammonia, and after the fumes in the flask had disappeared, the liquid was washed out with water, acidulated with hydrochloric acid, and treated with sulphureted hydrogen. A slight brow coloration resulted. Several standard solutions of mercury were then made, and tested with sulphureted hydrogen in the same manner. The liquid from the flask gave a deeper color than the solution containing 0·00006 grm. of mercury and a lighter color than that containing 0·00012 grm. It may therefore be assumed that the flask contained about 0·00009 grm. of mercury vapor.

Subsequently the same flask was used, and a tube of mercury 24 mm. in diameter (or exposing nearly three times as much mercury surface as the first) suspended in it, and allowed to stand for a month. Treated in a similar manner, the color was nearly the same (a little lighter if anything) as that produced by a solution containing 0·00012 grm. of mercury. One liter of the air in the flask therefore contained—

$$\frac{0{\cdot}00012}{1{\cdot}9} = 0{\cdot}00006316 \text{ grm. mercury.}$$

As the theoretical weight of a liter of mercury vapor at 20° C. and the normal pressure is 8·3474 grms., the volume of the vapor in 1 liter of the air was—

$$\frac{0{\cdot}00006316 \times 1000}{8{\cdot}3474} = 0{\cdot}007566 \text{ c. c.,}$$

or $\frac{1}{132160}$ of the total volume. The pressure of the mercury vapor was therefore—

$$\frac{760}{132160} = 0{\cdot}00574 \text{ mm.,}$$

whereas Hagen's number for 20° is 0·021 mm.

It may be observed that this method might have been expected to give rather an excess than a defect of the quantity of mercury, in consequence of condensation of mercury on the sides of the flask; and although the experiment was of a somewhat rough character, it seems to show that Hagen's number is too high.

A paper has also been published by Hertz (*Ann. Phys. u. Chem.*, N. F., xvii., 193), in which he estimates the pressure of the vapor at 20° to be only 0·0013, or only about one-fifth as great as indicated by the foregoing experiments.

* Read before the British Association, Southport meeting.

## THE PRECIPITATION OF GLUCOSE WITH LEAD ACETATE.

P. LAGRANGE has recently published a paper in *Comptes Rendus* on the action of acetate of lead upon glucose. He says that in France, when determining the amount of inverted sugar in cane sugar, it is customary to first precipitate the organic matter by shaking with acetate of lead so as to obtain a clear solution. He found, however, that some of the inverted sugar (which is similar to glucose) is precipitated by this treatment, as shown in the following table, which gives the analyses of three varieties of raw sugar and two of refined sugar, both before and after treatment with the lead solutions. The first column under each refers to sugar subjected to the lead treatment, the second without lead:

| | Sugar from Egypt. | | Sugar from Reunion. | | Java sugar. | | Refined sugar. | | Refined sugar. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | I. | II. | I. | II. | I. | II. | I. | II. | I. | II. |
| Crystalline sugar........ | 80·50 | 80·50 | 89·00 | 89·00 | 91·00 | 91·00 | 88·50 | 88·50 | 80·00 | 80·00 |
| Inverted " ........ | 3·07 | 5·03 | 2·82 | 3·80 | 3·32 | 4·40 | 3·43 | 5·30 | 4·45 | 7·10 |
| Salts............ ....... | 2·43 | 2·43 | 0·95 | 0·95 | 0·32 | 0·32 | 1·20 | 1·20 | 2·97 | 2·97 |
| Water.................. | 5·98 | 5·98 | 2·02 | 2·02 | 2·00 | 2·00 | 4·40 | 1·40 | 6·00 | 6·00 |
| Organic substance ....... | 8·02 | 6·06 | 5·21 | 4·23 | 3·31 | 2·28 | 2·47 | 0·60 | 6·48 | 3·98 |
| | 100· | 100· | 100· | 100· | 100· | 100· | 100· | 100· | 100· | 100· |

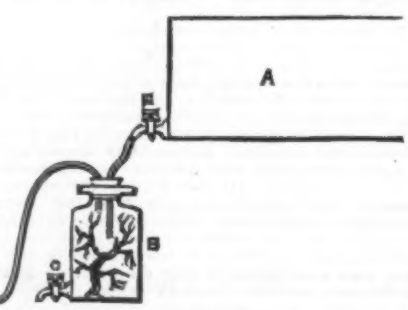
It will be observed that much more inverted sugar, up to 2 per cent., was found before treating it with lead.

Lagrange also analyzed the precipitated lead compound, by decomposing it with sulphydric acid and then filtering out the sulphide of lead. In the yellow filtrate he proved the presence of a quantity of inverted sugar that exactly corresponded to the difference between the quantity found before and after treating it with lead acetate. From this it is very evident that it is not allowable to treat sugar sirups with lead salts before estimating the invert sugar, but it has no influence on the cane sugar.—*Chem. Zeitung.*

## PRODUCTION OF OXYGEN LIGHT.

SOME recent investigations of Dr. Phipson, which are published in the *Chemical News*, tend to elucidate in a remarkable manner the circumstances under which oxygen is evolved when light acts on growing plants. Dr. Phipson says:

In almost all text-books it is stated that plants have the power of decomposing carbonic acid and liberating its oxygen, while the carbon is "fixed in the vegetable tissue." This statement is quite incorrect; plants have no power of decomposing carbonic acid into oxygen and carbon, or into oxygen and carbonic oxide. Even in the laboratory, the decomposition of carbonic acid is an arduous undertaking requiring violent methods, such as that which I showed formerly in my paper on magnesium by the action of that metal on carbonate of soda at a great heat. Plants absorb carbonic acid from water or air when it is present in the proper proportions (in large quantities it appears to poison them), and oxygen is evolved from their tissues as a consequence of this absorption; but the carbonic acid is not decomposed.




On a fine summer morning, when the sun has been above the horizon four or five hours, we see the *Zygnema* and *Conferva* borne up to the surface of pools of stagnant water by thousands of minute gas bubbles. When this gas is collected and analyzed, it is found to be very pure oxygen. The *Protococcus pluvialis* and *P. palustris*, which are among the simplest of unicellular algæ, I have found to be very remarkable in this respect.

Expose a saucer to the rain for a few months, or leave it, full of pump-water, exposed to air and light for some weeks, and it soon contains *Protococcus pluvialis* in abundance. Place some small dead branches of poplar in the saucer, and both *P. pluvialis* and *P. palustris* develop rapidly upon them in the course of a week or two.

These small branches can then be placed in a flask full of pump-water, and the evolution of oxygen observed under the influence of the solar rays.

When higher plants, such as *Achillea millefolium*, are experimented on in this way, the gas accumulates at the extremities of the leaves, sometimes in bubbles of considerable size, which finally escape and come to the surface in quantities varying from the size of a pin's head to that of a pea or a bean. But with the *Protococcus pluvialis* and *P. palustris* the escape of gas is constant and each bubble is of the minutest size. No sooner do the sun's rays strike the flask, than a series of these microscopic bubbles—veritable atoms of oxygen—commence rising in all directions, and from their great number create quite a froth upon the surface. The flask being turned upside down for the purpose of collecting and ascertaining the composition of the gas, this state of things will continue for about three days; after that time all the carbonic acid contained in the water is absorbed, and the escape of oxygen gas ceases. (A minute quantity of caustic soda will cause it to cease on the first day, by depriving the plant of carbonic acid.)

When the water is renewed, the same phenomenon recommences, so that by keeping up a constant supply of pump-water the production of oxygen may be kept up for months and probably years together.

This is effected by means of the simple apparatus now to be described:

The water used is pump-water (water that has been boiled or distilled will not answer, nor will the phenomenon occur if the slightest quantity of alkali of any kind be present in the water). The tank, A, is of slate or eathernware; it is full of pump-water on which the sun's rays cannot act on account of the opacity of the sides; it is kept filled and covered. B is a large wide mouthed and tubulated glass flask, in which are placed the dead branches of poplar covered with *Protococcus pluvialis* and *P. palustris*. (These microscopic plants are almost invisible save that here and there on the dark epidermis of the branches little patches of green matter are observable.) The flask, B, is exposed to the direct rays of the sun. The flow of water from the tank, A, is regulated by the tap, E, and that from the flask by the tap, C, so that the contents of the latter are completely renewed in the course of three days; or the water in B may be completely drawn off every third or fourth day.

In these conditions any quantity of oxygen may be produced in a short space of time; the quantity yielded in any given interval of time depends solely upon the size of the apparatus.

The oxygen can be received in a gasometer by means of the tube, D, or into a graduated tube. In the latter case, the apparatus appears capable of being transformed into an excellent actinometer; the number of divisions (cubic centimeters of gas) taken on the graduated tube every day from 8 to 9, or 12 to 1, giving the exact measure of the actinism for the day in question. But the present form of the apparatus is not suitable for this purpose; for, supposing there were five hundred thousand distinct individuals of *P. palustris* present in the flask on any given day, this number might be six hundred thousand or more on the following day, and so the results would not be comparable.

The small dead poplar branches form a very convenient medium for transferring the *Protococcus* from one flask to another (for instance, when the flask first used becomes dull or opaque and requires cleaning). Having been exposed to the rain for a long period of time, they are invariably covered with *P. pluvialis* and *P. palustris*, though the presence of these minute plants is not easily recognized, and when placed in pump-water, exposed to the light, the latter develop rapidly, and multiply enormously during the whole year.

Two analyses of the gas produced by *Protococcus pluvialis* and *P. palustris* in these experiments gave me:

Oxygen 98·7 and 98·0 per cent.

## AN ACTINIC METHOD FOR THE DETERMINATION OF ORGANIC MATTER IN POTABLE WATER.

WITH THE APPLICATION OF THE METHOD TO THE WATER SUPPLIES OF PHILADELPHIA, NEWARK, JERSEY CITY, BROOKLYN, AND NEW YORK.

By Dr. ALBERT R. LEEDS.

AT the present time there is no method known of determining accurately the amounts and kinds of organic matter existing in the water we drink. The amounts are so small, the kinds so various, the instability of much of the organic matter so great, that the best we can do is to make a tolerably accurate estimation of the total amount, and endeavor to find out what portion of this is safe and what is possibly dangerous to health. To make this scientific guess, so to speak, various expedients have been hit upon, and a vast deal of thought, controversy, and time have been expended. The mode most in vogue is to heat the drinking water with an alkali and a powerful oxidizing agent, and to find how much ammonia distills off from it. The ammonia thus obtained is regarded as a measure of the putrefiable organic matter present. Another way is to find out just how much nitrogen and how much carbon are present, and, from the fact that animal substances have a much higher proportion of nitrogen to carbon than vegetable substances, to conclude whether any dangerous bodies of animal origin are present. These two ways are greatly in use in England. The Germans place great confidence in a third method, which is to find how much of the organic matter is capable of being oxidized by permanganate of potash when the water is being boiled with this strong oxidizer, and to regard this oxidizable fraction of the organic matter as the part dangerous to health, and of importance therefore to consider. In France, again, much stress is laid upon finding out how large an amount of oxygen is dissolved in the water, on the ground that if there is much less present than is always found in really pure water, there is reason for believing that the deficiency is due to the absorption of oxygen by bodies undergoing decay and putrefaction.

The new method I am about to propose depends upon the fact that compounds of silver are not decomposed by light, when they are in solution in water, unless organic matter is present in the water also. If sufficient care is taken to exclude every trace of organic matter, even such as might accidentally enter from the dust of a room, silver solutions may be kept in the sunlight for years without

change. Another fact lying at the foundation of this new process is, that stable organic bodies, like sugar, starch, gum, etc., have very little influence, while decomposing substances, like excreta of all kinds, throw down the silver very rapidly.

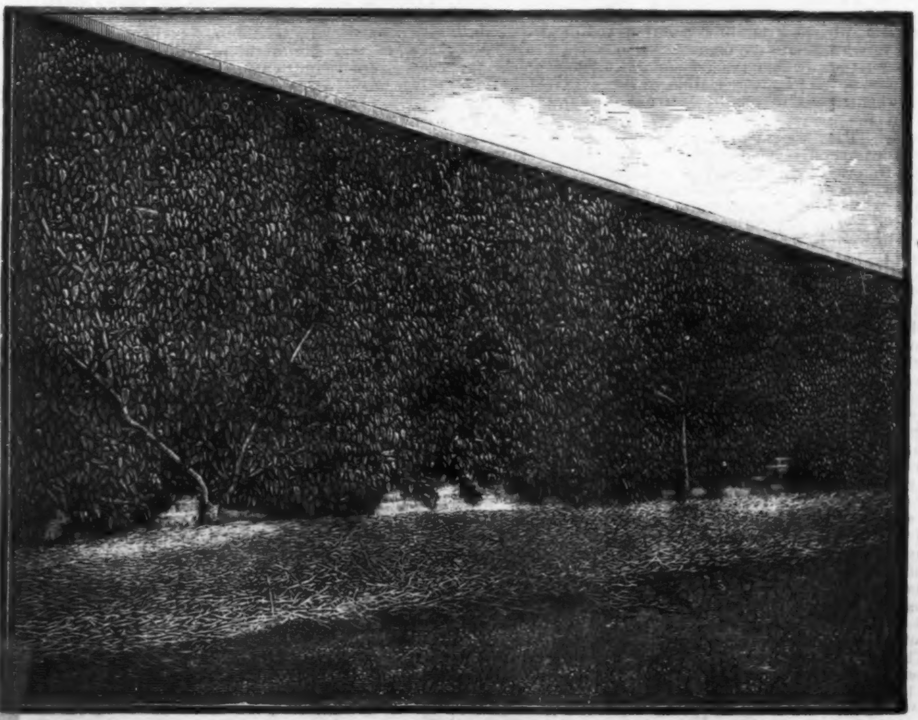
[Here a bottle was shown in which some sewage-water had been added to a solution of nitrate of silver, and then exposed to sunlight. The whole interior of the bottle was covered with a bright mirror of metallic silver. Another bottle was shown containing some Croton water drawn at the Christopher St. Ferry last Saturday. It was covered at the bottom with a black deposit of metallic silver, nearly but not quite so great in amount as a similar sample taken from the Passaic River (the water-supply of Newark and Jersey City, a week before.]

The amount of silver thus thrown down can be readily weighed, and the relative amounts of organic matter present in the water thus determined. A sample of Brooklyn water, taken March 4th, when the water had deteriorated, showed this fact by the large amount of silver which it precipitated. And during the month of January, when I was called on to Philadelphia to examine their water supply, at that time very offensive to both smell and taste, this method of examination was extensively used. It showed, among other things, that when sufficient air was passed through the Philadelphia water to raise the percentage of oxygen to the proper amount the decomposable organic matter was largely destroyed; and samples thus treated threw down just so much less silver, on exposure to sunlight, as there had been organic matter destroyed by previous oxidation in contact with air. This elucidated the origin of the difficulty with the Philadelpnia water. It had not been aerated sufficiently to get rid of the decomposable organic matter which it contained, and which communicated its offensive taste and smell.—*Proc. N. Y. Academy of Sciences.*

## THE PEACH WALL AT DITTON PARK.

WE have occasionally made reference to the excellence of the culture of stone fruits on open walls as practiced at Ditton Park, Slough, by a veteran gardener, Mr. Lindsay, and something in accord with the spirit of the old proverb about the proof of the pudding, etc., now present an illustration of a portion of the peach wall in these gardens taken at the end of August by Messrs. Runnicle Brothers, photographers, of Eton, while the trees were laden with fruit. Unfortunately, owing to the strong reflective power of the luxuriant glossy leafage as compared with that of the fruit, the latter does not stand out so clearly as could be desired; but our readers may accept our assurance that every tree in the gardens, whether peach or nectarine—and there are many such as are represented—was fully laden with very fine fruits, such as would have done credit to any gardener in the kingdom. The three trees seen in the picture speak for themselves, and better display the grand way in which the wall is covered than would one having a far longer perspective. These three trees cover a length of exactly 56 feet of wall, the which is clear 10 feet in height, and in point of health, vigor, and fruitfulness could not be excelled. The one in the foreground is an Elruge nectarine nine years planted; the second is a Noblesse peach, and the third Walburton Admirable peach. On the wall immediately to the left of the part shown in the picture is a Lord Palmerston peach, five years planted, that carried nearly twelve dozen of grand fruits, and next year will quite cover its allotted space of wall. Belle Bosc, Violette Hative, and Barrington are also huge trees, covering the wall completely and fruiting well.

It is one of the most conclusive proofs of the excellence of Mr. Lindsay's culture and general treatment of his trees that he seldom misses a crop; indeed, last year, when peaches were generally thin, he had a heavier crop than this year, though the past season has been most productive. Though the illustration represents a portion of the outer garden wall, yet there are some noble trees within the garden, and notably a Walburton Admirable, 7 yards in length, that covers the wall from top to bottom. The old Buckingham Mignonne is represented by a fine tree, 18 feet by 10 feet high, and though said to be the same as the Barrington, is here found to be earlier. It carried a grand crop. A Lord Palmerston, now 10 feet by 9 feet high, transplanted in the spring, carried, in spite of its removal, a splendid lot of fruit. The earliest kind grown is Early Louise, which does well, and the latest is the Salway, the which, a fine tree, keeps its fruits well into November, and ripens as well as the Salway ever does out doors. While the not uninteresting matter of size of flower may presnt itself to some readers' minds, it is a fact that at Ditton little heed is paid to that subject, but that kinds are grown that exhibit comparative hardiness. Perhaps it is because gardeners have not sufficiently considered that important feature in out door peaches that so many failures have resulted. In any case good drainage and culture are more relied upon here for the production of good crops of fruit than spring coverings, of which but little is used. In natural advantages we do not see that Ditton possesses any beyond what are found in most southern gardens.—*The Gardeners' Chronicle.*



THE PEACH WALL AT DITTON PARK, SLOUGH.

## HOW APPLES AND PEARS BEAR THEIR FRUIT.

As the season of fruit tree pruning is now upon us, the accompanying illustrations, showing the habit and fertile how the natural fruiting spurs are produced abundantly, without pinching or pruning. Fig. 2, A B, represents one and the same shoot cut in two at the node, C. They were kindly drawn for me from nature by Mr. F. W. Burbidge, and the others are from photographs of *bona-fide* examples. The terminal shoot, A, represents this year's growth with leaf-buds, and the two-year-old shoot, B, shows the leaf-buds converted into fruit-buds, which should bear fruit the third year. The sap finding a ready outlet in the terminal shoot, A, produced from the point of B at C, no side shoots are produced on the two-year-old growth, but the leaf-buds are only converted into fruit-buds, which will multiply in number every year until they become large clusters. The restrictive pruner would pinch these shoots after they grew a few inches, which would cause the permanent buds to break into shoots, which he would pinch again as often as they pushed, and all with the object of causing the pro-

Fig 1



Fig. 2

BRANCHES OF UNPRUNED APPLE AND PEAR TREES.

disposition of the apple and pear tree, unassisted by the pruning knife or any of those manipulative processes deemed so essential by a certain school of cultivators, may be of service to your readers. The figures show the apple in bud, in flower, and in fruit; illustrate the true habit of the tree better than any description in words could do; and show duction of fruit-buds, which, it will be seen, the tree naturally produces of its own accord, and far better, when let alone.

Fig. 3 shows similar unpruned shoots in flower, and Fig. 1 shows one in fruit, the original of which was cut from an unpruned tree in a cottager's garden, from which many more like it could be procured. Such examples show the pruner what he has to do in order to produce fruitful trees. Provided he does not object to his trees growing in their natural form, which is the handsomest of any, he does not need to touch the branches, except to shorten straggling shoots at the winter pruning, just to preserve the balance among them, and occasionally, perhaps, to thin out branches where too crowded. Fig. 1 is a four-year-old branch, about 3 ft. long, and bore forty-two apples. I consider it a very pretty example in its way. It has done no more than extend at the point each year, leaving a perfect wreath of natural and fertile spurs behind it.

The number of fruiting buds an apple or pear tree shoot will produce the second year depends on the variety. By a wise provision of Nature they are, as a rule, most thinly placed on those kinds which bear the largest fruit, and *vice versa*. When we reflect that each single fruit-bud produces a cluster of flowers—a far greater quantity than can mature fruit—we see what bountiful provision Nature has made to insure a crop, climate and other conditions being favorable, and that no kind of pinching or pruning is needed to help her. Free growth and root-pruning will accomplish everything. We have other photos. of both pear and apple branches in fruit equally as good as the one shown and taken this season, but the above is sufficient, for our present purpose.—*J. Simpson, in The Garden.*

## THE EVIDENCES OF ANCIENT GLACIATION IN NORTH AMERICA, AND THEIR BEARING ON THE THEORY OF AN ICE PERIOD.*

By Prof. J. S. NEWBERRY.

PROF. NEWBERRY exhibited a map of North America, on which he had represented all the known glaciated areas, and described, chiefly from his own observations, such as lie within the limits of the United States. He showed from the facts given, first, that glaciers once covered most of the elevated portions of the mountain belts in the far West, as far south as the 36th and, in the eastern half of the continent, the 40th parallel; second, that the ancient glaciers were not phenomena produced by local causes, but were evidences of a general climatic condition; third, that

* Abstract of a paper read before the N. Y. Academy of Sciences, 1883.

they could not have been produced by a warm climate and an abundant precipitation of moisture; fourth, that they were the products of a general depression of temperature, and therefore were proofs of the truth of the glacial theory. The facts presented may be briefly summarized as follows:

The glaciation of the Sierra Nevada is general and very striking; it has been described by Whitney, King, Le Conte, and others who have given abundant proof that all the highest portion of the range was once covered with snow fields, and that glaciers descended from these down the valleys on either side

Mt. Shasta once bore many great glaciers, of which miniature representatives still remain.

The Cascade Mountains exhibit perhaps the most stupendous record of ice-action known. All the higher portions of the range are planed down and furrowed by glaciers, which descended into the valley of the Des Chutes on the east, and that of the Willamette on the west, as shown by the observations of the speaker in 1855, at least 2,500 feet below the present snow line. Mt. Ranier still carries glaciers of considerable size; and all the country around, as well as about Puget's Sound and on Vancouver's Island, shows evidence of former glaciation. In British Columbia the signs of ancient glacial action, as shown by George M. Dawson, Dr. Hector, Richardson, etc., are conspicuous in all the high country explored. The valleys of the Wasatch range were once filled with masses of ice as far south as central Utah. A type of these was the Little Cottonwood glacier, of which the record has been carefully studied by Dr. Newberry. It formed in a cirque at Alta, 10,000 to 11,000 feet above the sea, had a length of about ten miles, a thickness—as shown by the line of granitic blocks left along its sides—of 500 feet or more, and its lower end was only 5,500 feet above the sea.

The glaciation of the Uinta range has been graphically described by King, who says that the ancient glaciers of these mountains occupied a greater area than all those of the Alps.

In the Rocky Mountain belt the signs of glaciers abound, from the northern part of New Mexico through Colorado and along the great divide in Wyoming, Montana, and Idaho.

In these Western mountain ranges the glaciers were far more extensive than any now to be found on the earth's surface, unless on the Antarctic continent or Greenland. The record they have left consists of planed, grooved, and striated rocks, covering immense areas, lateral and terminal moraines, moraine lakes, etc., a record which is as legible and reliable as any printed page.

In the country east of the Mississippi, the evidence of ancient glaciation is even more widespread and impressive than in the far West. All the surface rocks of Canada, of New England, of New York, and the greater part of Ohio, Indiana, Illinois, and Wisconsin, bear marks of ice-action, and are generally covered with a sheet of drift material which has been carried by glaciers from the north southward, often many hundred miles. This glaciated and drift covered area extends from Maine and Massachusetts westward in a belt parallel with the arch of the Canadian Highlands, 500 miles wide and more than 2,000 miles long. Its extension northward from the head waters of the Mississippi has not been traced further than Lake Winnipeg, where it was studied by Hind; but there are good reasons for believing that it extends to the Arctic Ocean, and that the great lakes of the North, like those of the St. Lawrence chain (Superior, Huron, Michigan, etc.), are old river valleys scooped out and modified by glaciers. Above the Canadian line, George M. Dawson reports that the glacial drift from the Canadian Highlands extends westward till it meets that which was spread eastward from the Rocky Mountain belt.

From the facts already gathered, it is a justifiable inference that fully one-half of the continent of North America, north of the 36th parallel, was at one time covered with ice or perpetual snow, and, so far as we can now judge, the glaciation of all the areas enumerated was synchronous, and that it occurred at the same time with the great expansion of the glaciers of Europe.

Some writers have attempted to prove that a large part of the glacial phenomena described are really the work of icebergs, and the consequences of a great continental subsidence; but no man who has studied the inscriptions made by glaciers will hold to such a theory, when he has traversed much of the glaciated areas east or west of the Mississippi.

While the phenomena described above are unmistakable, and constitute an indisputable record of the prevalence of ice sheets over great areas of our continent, much speculation has been lavished upon the possible causes of such accumulations of ice and snow as have here left their marks. In a voluminous and elaborate review of the subject recently published by Prof. J. D. Whitney, the glacial record is misrepresented and belittled. By this author it is stated that ice has little or no eroding power, while every one who has traveled through the glaciated areas has noticed the peculiar impress left upon the topography by the old glaciers; and the sheet of drift material now remaining, as the result of ice-erosion—over one area, 2,000 miles long and 500 miles wide, from 30 to 50 feet thick—is in itself a sufficient answer to this assertion.

But our drift deposits are only a remnant of the mass of material eroded by the glaciers. Most of the flour they ground—the clay—has been washed away, and over great areas, only the bran—gravel, sand, and bowlders—remains. All the streams flowing from glaciers are turbid with sediment supplied by the grinding of rocks by ice. This has been measured in some cases, and the erosive power of glaciers has then been not only demonstrated, but quantitatively determined; for example, the daily transport of sediment from the Aar glaciers in August is 280 tons, and Helland states that 69,000 cubic meters of solid rock are annually worn away by the Justedal glacier of Norway (Geikie); and yet we are told that ice has little or no eroding power!

By Professor Whitney the few glaciers of which the record cannot be ignored or sophisticated are considered as the product of local causes, and not as evidence of an *ice period*, which it is the great object of his book to disprove. The immense extent, however, of the glaciated area, reaching, as it does, from the Atlantic to the Pacific, from the 36th parallel northward on high lands, and the 40th on low lands, as well as the evidence of approximate or exact synchronism in the phenomena, make it impossible to accept the theory of local causes.

We are in fact driven to the necessity of referring the record to a general climatic condition. What this condition was, is the next point for investigation; its cause or causes still another. Professor Whitney, following Lecoq and others, claims that since snow and ice are moisture evaporated elsewhere by heat, the extension of glaciers at any time or place is simply an effect of increased heat and not cold; and hence if there ever was an ice period—meaning a time when glaciers were more widespread than now—it must have been a warmer period than the present, with more copious precipitation. Only a few of many facts need be cited to show that this theory is untenable. First, glaciers are now confined to altitudes and latitudes where the temperature is low—Alpine summits and the Arctic and Antarctic continents. To widen and intensify the conditions which now produce glaciers would necessarily induce an extension of snow and ice. Second, on the Cascade Mountains we find a copious precipitation of rain and snow, but no ice, where great glaciers formerly existed. The snow line is 7,000 feet above the ocean; and there the temperature is high enough to permit the most vigorous growth of trees and smaller plants. The fir forests here meet the snow banks in actual mechanical conflict, and the front ranks of trees, though of good size, are weighed down by the snow, and grow prone and interlaced upon the ground.

The snow fields rise 3,000 to 4,000 feet above the snow line, and there are miniature glaciers at the heads of the valleys—relics of the great glaciers that once filled these valleys to their mouths. The precipitation remains, the snow fall remains, but the glaciers are gone!

Here we have just the conditions most favorable to the formation of glaciers, according to the theory of those who regard them as *thermal phenomena*, but no glaciers, *because of the high annual temperature.* With a depression of temperature, which should cause the rain bearing winds from the Pacific to do all the year what they now do only in winter, viz., heap up snow on the highlands, the mountain slopes and draining valleys would soon be occupied by glaciers again. So if winter conditions could be made permanent on the great watersheds of the Canadian Highlands, and the flow of the St. Lawrence, Mississippi, and Red River be retained in the form of snow and ice, glaciers would soon fill again the lake basins, override the highest summits, and cover with an ice sheet all the old glaciated areas. Even if the evaporation from adjacent seas was somewhat diminished by the cold, that would not change the result, though it would prolong the time. If the evaporation in the region surrounding the North and South poles is, as we have demonstrative evidence, sufficient to produce continental glaciers on Greenland and the Antarctic continent, it requires no argument to show that like conditions would produce like results in what is now the temperate zone.

The relations which the ancient great lakes of the far West bore to the former glaciation of the same region is an interesting subject of inquiry. It has been suggested that it is the relation of cause and effect, but this seems hardly possible. They may have been synchronous, and to some extent co-operative phenomena, but the relationship was rather fraternal than filial. The cause of the former great breadth of water surface was either an increased precipitation or a diminished evaporation. We not only have no record of any change in the relationship of the North American continent to the Pacific, in modern times geologically speaking, but the evidence against any change is conclusive. Everything indicates that the system of rain-bearing winds, the topography, and hence the precipitation have been substantially the same for a long period. But any cause which could produce a depression of temperature would certainly diminish evaporation, and form lakes in the valleys and glaciers on the mountains. To prove this, we have only to cite the phenomena presented by summer and winter in the Western Territories. In winter, the snowfall on the highlands is heavy, and the accumulation of moisture in this form is large. The skies are cloudy, and evaporation is small. In summer, the sky is cloudless, the heat intense, evaporation and desiccation rapid. In the spring the snows melt, flood the valleys, and form temporary lakes, which in midsummer dry up to *playas*. A perpetuation of the conditions of winter and spring would inevitably produce glaciers and lakes, and these would be essentially synchronous. A depression of temperature, which should intensify and prolong the present winter, and make midsummer like the present May, would inevitably produce glaciers and lakes, in the main synchronous, and thus would accomplish all that we find recorded. But to intensify and prolong summer by an elevation of temperature would not produce either lakes or glaciers.

That the ice period was cold and not warm is further proved by the prevalence of an Arctic flora and fauna on the land and in the sea, in all regions near the old glaciers. The Arctic shells of the Champlain, the Arctic plants in the Quaternary clays, the reindeer, musk ox, woolly mammoth, and woolly rhinoceros all tell the same undeniable story.

From the facts cited, and others of similar import in the southern and northern hemispheres, we must conclude:

1. That a glacial period has prevailed simultaneously or alternately in both hemispheres.

2. That the glacial period or periods were periods of lower temperature than that of the present day.

An inquiry into the *cause* of the cold of the ice period would open a question beyond the scope of this paper, and one too broad and suggestive to be discussed to any purpose in the time at our command. I may say, however, in passing, that I have elsewhere shown that no arrangement of land and sea, consistent with the known facts of Tertiary and Quaternary history, will enable us to refer that cold to any topographical or even telluric cause. Some extraneous influence, such as a variation in the heat radiated by the sun, as suggested by Newcomb, or a variation in the eccentricity of the earth's orbit, as advocated by Croll, or some other cosmical cause must be credited with effects so widespread and stupendous as the ice period has left behind it.

## THE SWISS LAKE DWELLERS.

THE lowering of the waters of Lakes Neuchatel, Marat, and Bienne, that the Swiss Confederation has been engaged at for the last two years, has proved fortunate for archæologists, for pick in hand they have, on relatively dry earth, been enabled to gather the treasures that were buried in the ruins of the lacustrine villages. For this reason, archæological "finds," which are so meager in lakes in which the searching has to be done by means of tongs and drags in deep water, have multiplied in unheard of proportions in the hands of searchers on the banks of these favored lakes. The debris of human industry have accumulated by thousands and thousands in their hands, and our knowledge of the strange civilization of the first inhabitants of Switzerland has on this occasion made interesting progress. As a proof of this I would only cite the very important memoir which Professor Theophile Studer has recently published in the *Bulletin* of the Society of Naturalists of Berne. Taking up, after Mr. L. Rutimeyer, of Basle, the study of the bone heaps found in the archæological stratum of the palafittes, and utilizing the great mass of material collected in the lacustrine stations of Lake Bienne, this gentleman has drawn therefrom some most interesting details in regard to the variations of the animal population in the different periods of these prehistoric ages and in regard to the progress in domestication of such races as are useful to man.

FIG. 1.—RESTORATION OF ONE OF THE HABITATIONS OF THE SWISS LAKE DWELLERS.

If it be desired to ascertain the present state of our knowledge as to the human industries in the lacustrine epochs, let a study be made of the volume that Dr. Victor Gross has just published under the title of "Les Proto-Helvetes, ou les Premiers Colons des Bords des Lacs de Bienne et de Neuchatel" (Paris, 1883: J. Baer). The author, who is a practicing physician at La Neuveville, has had the good fortune to get hold of the product of all the private gatherings made upon the banks of Lake Bienne; a good portion of those from Lake Neuchatel have fallen into his hands, and he has succeeded in forming a collection that has no equal as regards its richness and the number of specimens, and especially as regards the rarity of the pieces, often unique, that he has accumulated therein.

Desiring to permit the scientific world to enjoy these treasures, and responding to a demand that has been addressed to him from every quarter, he offers us a beautiful quarto volume in which he describes the principal results of his researches. What gives an inestimable value to this work is the plates with which it is embellished. Dr. Gross has been at the pains of familiarizing himself with photography, and has himself, in 33 plates, grouped more than 950 of the most important pieces in his collection.* His photographic plates have been accurately reproduced by a process of photo-engraving by Baeckmann, of Carlsruhe, and, thanks to this ingenious utilization of the most improved processes of modern artistic industry, the reader may study at his leisure, and in a most profitable manner, the finest collection known of prehistoric archæology. I do not hesitate to name it the finest one, because, notwithstanding the series of some of the large museums are perhaps more numerous than those of Dr. Gross, it has the superiority over all others in that it deals with a single civilization in the different eras of its development, with the same people in all the details of its inner life, with an incomparable wealth of demonstration. The ruins of each of our lacustrine cities

* In Fig. 2 we reproduce some of the characteristic objects shown in these plates.

may be compared to a Pompeii on a small scale. Let us suppose fifty Pompeiis that were successively destroyed from the first dawn of Roman history until the end of the decadence, and we may imagine what treasures of documents might be found therein to get up a history of the arts, industries, and civilization in ancient Italy.

A study of the large collections of Swiss antiquities gives us one very clear impression, and that is that the lacustrine population was rich, especially in the period known as the *bronze age*. Here we see on all sides signs of an exuberant fortune, and indications of poverty nowhere. The inhabitants of the palafittes* had mechanical devices at their disposal which were probably simple but sufficient for fixing in the ground the thousands and dozens of thousands of piles upon which they erected their villages. In possession of agriculture and the raising of cattle, they had but exceptional recourse to the more primitive art of hunting for their nourishment. An extended commerce brought them metals, amber, glass beads, and ornamented objects of foreign origin; and a very pure taste raised their workmen to the dignity of genuine artists. The reader who admires, in Dr. Gross's plates, the representation of the remarkably elegant of certain objects that could not have reached our country except by means of a very extensive commerce. Amber had already been brought to them from the shores of the Baltic, and rare stones which possessed very valuable properties, and of which they made their cutting utensils, came to them from still further away. Nephrite, a beautiful, light green colored stone, semi-transparent, was brought to them from Turkestan or Southern Siberia; jadeite, of grayish color, came from Burmah; and chloromelanite, a black stone with yellowish streaks, probably also came from Asia, but from deposits as yet unknown.

The lacustrine epoch lasted a long time, and man in our country, as elsewhere, has risen from that primitive civilization in which he as yet did not know metals up to a superior one in which he came into possession of bronze and afterward of iron. Whatever a certain German school may have said of it, the existence of an age of bronze, intermediate between that of stone and iron, is absolutely demonstrated. This continuous and progressive development is shown, with every evidence, from an archæological study of the human industries, and it is proved definitely by a study of the bony remains of animals collected in the ruins of the lacustrine


FIG. 2.—OBJECTS IN THE COLLECTION OF DR. VICTOR GROSS.

1. Sword hilt of bronze from the Mörigen station. 2. Ornamented ear bob (Auvernier). 3. Cup of hammered bronze (Corcelettes). 4. Clay vase incrusted with tin. 5. Yew wood comb (Fenil). 6. Bronze ear bob (Auvernier). 7. Earthen mould containing matrices for two knives and twenty-seven rings (Mörigen). 8. Hairpin (Estavayer). 9 and 10. Bronze knives (Auvernier). 11 and 12. Ear bobs made of stag's horn.

arms (Fig. 2, Nos. 1, 3, 4, 9. and 10), tools, and ornaments of bronze and vases of pottery, will not be able to deny that the civilization of our lacustrine dwellers was rich and flourishing.

The mass of metal that they possessed was considerable, and, on adding up the innumerable pieces of bronze found at certain stations, I do not think I will be wrong in holding that, populations being equal, they had at their disposal a weight of bronze nearly equal to that of the iron that we find at present in any one of the most well-to-do villages in our country—the heavy masses of castings in our large agricultural machines being excepted. Dr. Gross has counted the pieces of bronze that have come from Lakes Bienne and Neuchatel and are preserved in public and private collections of Switzerland, and has found that they amount to 19,000, more than 5,000 of them being in his own private collection. This richness of the "Proto-Helvetians" (as Dr. Gross very happily styles them) in the bronze age was already as real, though less evident, in the stone age. I draw this conclusion from the presence in the ruins of this epoch stations. As regards this, the conclusions of Mr. Studer are as affirmative as were, twenty years ago, those of Mr. Rutimeyer.

In the age of stone Dr. Gross distinguishes three periods, to wit: A first period, a primitive and poor one, with coarse pottery, badly worked stones, and an absence of nephrite and other stones of foreign origin. The station of Chavannes, near La Neuveville, is for him the type of this remote age. A second period shows the stone civilization in all its luster. The instruments of stone are richly cut, the exotic stones are abundant, and the art of the potter is already much improved. Locras and Latrigen represent this age at Lake Bienne. A third period shows the introduction of metals. The general character remains the same as that of the preceding—the same pottery and the same abundance of stone instruments. But the first metallic tools were imported. At Finels, on Lake Bienne, we find copper that has as yet been worked in a very primitive manner; and at Morges, in the Roseaux station, we have bronze in the form of very simple hatchets. After this came the beautiful age of bronze, with its magnificent development of civilization, and then, later, appeared iron.

A discussion in this place of the numerous general or special questions raised by Dr. Gross' book scarcely enters the scope of this article, but I shall select a single one that will show what interest there is in the problem.

Bronze, the chief metal used in the finest period of lacustrine civilization, is not indigenous; nor are the copper and tin which, through their admixture, give this metal found either in our Swiss plain or in the Jura. Ores of copper exist, it is true, in certain valleys of the Alps, but it is very probable that the ancient lacustrines received this metal from more distant countries, where mines were more easily worked. This is certain, at all events, as regards tin, the nearest deposits of which are in Saxony, at Cornwall, and in Spain. Were these metals—copper, tin, and bronze—brought to Switzerland all worked, or did they rather arrive in the state of ingot, and were they melted on the spot? Was there a local and indigenous industry, or were arms, instruments, and ornaments fashioned in foreign countries, and imported into this? The question has been for a long time debated, and it may now be answered as follows: Certain objects were imported already fashioned, for they evidently show the type of a foreign industry. A superb vase cast in bronze is preserved in the museum of Lausanne, and a clasp from Corcelettes, on Lake Neuchatel, is known whose form and ornamentation are manifestly Scandinavian. Other pieces, in larger number, recall forms known either in Southern France or in Italy. On another hand, ingots or pigs of unworked metal are very rare in our finds. It is probable, then, that the metal was oftenest brought through commerce, or gained by conquest or pillage in the form of worked objects.

But there was at the same time a local industry. Broken instruments were repaired or cast anew, and the lacustrines knew how to cast and hammer bronze in their villages. We have a proof of this in a relatively large number of moulds that are now in the Swiss museums—in those, among others, at Lausanne and Geneva, and in the Gross collection. In the plates representing this latter there are figured no less than three moulds in bronze of which two are in two parts, 8 halves or fragments of clay moulds, and 17 fragments of earthen ones (for example, see Fig. 2, No. 7). A single one of these stone moulds often served for casting different objects, and the 17 of Dr. Gross give matrices for 78 different pieces. In addition to these moulds, jets of bronze, hammers, anvils, shears, and punches complete the equipment of the founder, and demonstrate that his industry was indeed practiced *in loco*. Was the founder himself indigenous and sedentary, or indeed, as we at present see with casters of tin and cowbells (natives of Piedmont who traverse our country), was he an itinerant workman who traveled from one country to another? There is no decisive argument that definitely answers this question.

Have these few lines sufficed to give an idea of the importance of the discoveries made in recent years, and to show the extent of the knowledge that we now possess in regard to peoples whose very existence was ignored thirty years ago? They will, at all events, say that to the names that are already popular in this line of research—Keller, Troyon, Morlot, Desor, and Chantre—we should hereafter add that of Dr. V. Gross.—*F. A. Forel, in La Nature.*

## THE GREAT PYRAMID, AND THEORIES CONCERNING IT.*

AFTER a short sketch of the geographical position of the pyramids of Lower Egypt, illustrated by charts and maps, and a notice of their difference in structure, considered as tombs, from all the other tombs in the neighborhood, and a somewhat extended study of the monuments of the fourth dynasty, followed by a minute account of the Great Pyramid, and its peculiarities, and a notice of some of the fanciful theories with regard to it, the lecturer proceeded to show that the hitherto neglected difference of angle between the descending and ascending entrance passage of the Great Pyramid was really the key to the explanation of the otherwise unexplained fact, that all the pyramids have the entrance passage on the northern side, and approximately pointing toward the pole of the heavens. That these passages were intended, or rather that of the Great Pyramid, for some reason, to point as near as might be to the then polar star (Alpha Draconis) had already been generally admitted, but in attempting to make this a basis for chronology there is an uncertainty of some 1300 years in the case of the Great Pyramid, which has the entrance passage pointing about 3° 42' from the true pole. Twice in the processional movement of the stars, Alpha Draconis has been at this distance, once 3400 years B.C., and again 2160 years B.C. The former era is adopted by Mr. Proctor in his recent book; the latter, or near this, by Prof. Piazzi Smyth. Neither of these authors seems to have considered that the difference of angle between descending and ascending passages was of any particular significance. Mr. Proctor supposes that observations were made down the ascending passage, by reflection, for purposes of orientation. Some five years ago, the lecturer had suggested this use, not for purposes of orientation, but as indicating, by the change of angle of elevation of the pole star, the interval elapsed between the date of the commencement of the pyramid and the time of arriving at the altitude of the king's chamber, and this difference, 9 minutes of arc, corresponded to twenty-five years. Moreover, the angle of the ascending passage being the smaller, indicated that Alpha Draconis had already made its nearest approach to the pole, and was now receding, thus deciding for the later of the two periods, *i. e.*, 2160, or thereabouts, for the date of erection of this pyramid.

The lecturer proceeded to apply this hypothesis to the other pyramids. The so-called third pyramid on the Jeezeh hill, that of Mycerenus, is acknowledged by all to be later than the Great Pyramid, and the angle of the descending passage of this pyramid, as given by Vyse and Perring, when compared with the angle of that of the Great Pyramid as measured by Prof. Smyth, indicates that it was built some 80 years later.

The angles of the entrance passages of most of the pyramids have been very loosely measured, but taking them as they are, and applying the same hypothesis, the lecturer obtained the following results:

| | | |
|---|---|---|
| 1. | Great Northern of Dashoor, about | 2410 B.C. |
| 2. | Northern of Abouseer, about | 2260 B.C. |
| 3. | The "Second" of the Jeezeh group | 2170 B.C. |
| 4. | The "Great" of the Jeezeh group, at elevation of Kgs. ch | 2136 B.C. |
| 5. | The Southern of Dashoor | 2118 B.C. |
| 6. | The Pyramid of Mycerenus, 3d Jeezeh | 2090 B.C. |
| 7. | The Stepped Pyramid, Sakkarah | 2010 B.C. |

* Wooden structures supported by piles.

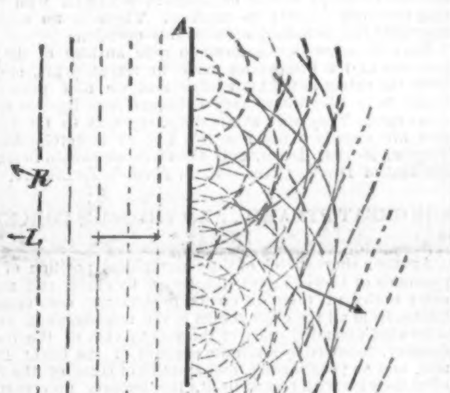
* Abstract of a lecture by Prof. Hamilton L. Smith, of Hobart College, Geneva, N. Y., before the N. Y. Academy of Sciences.

The last named had already been attributed by the ablest Egyptologists to the fifth dynasty; and in regard to the third in the list it had already been assigned to Cheops by Bunsen; and the fourth, the "Great," to his successor Shafre, or Cephren, this being the hieroglyphic name of the pyramid of this monarch. It would seem, then, that the so-called "first" or "Great Pyramid" on the Jeezeh hill was really the second, and it hardly seems probable, if it really was the first, that it would have been nearly pushed off the hill, when the whole situation was yet clear. The chalk marks, names of Shofo (Cheops) and Nu-Shofo, on some of the stones of the Great Pyramid, in places where it never was intended they should be seen, are of no value as determining that either of these kings built the pyramid; they were merely scribblings of the workmen. The lecturer showed that the builders of the pyramids had tube drills and saws, charged probably with beryls, for cutting basalt, syenite, and diorite; and that the testimony of the monuments as interpreted by Mariette, Maspero, Brugsch, and other scholars contradicted the statements of Herodotus, and proved that so far from being a degraded people tyrannized over by despotic monarchs, they were a highly intelligent and happy people, well governed, and with a comparatively pure and simple religious belief.

## RAINBOW RINGS ABOUT THE MOON.

ON the evening of the 15th Nov. last, at a few minutes after seven, the full moon presented an interesting appearance as seen from the northern suburbs of this city. Closely encircling the full moon was a series of distinct rings each composed of the rainbow colors. This appearance is rarely seen so perfect as to show the colors, and usually the rings and colors blend together to form the ordinary halo or misty appearance often seen in the evening around bright objects. This appearance has received by the aid of the undulatory theory of light a complete and satisfactory explanation.

This phenomena will be easily understood after we have carefully considered the action of an instrument used by the optician for analyzing light, known as the diffractive grating. By means of a very perfectly constructed machine a diamond point is made to rule lines so fine and so close together that several thousand will be included in the space of one inch. Such a machine is used to make these gratings. Another method of making these gratings is by photography. Lines ruled or printed close together may be copied on to the photographic plate on so small a scale that over a thousand will be included in the space of an inch.




RAINBOW RINGS.

If we look at a blue light through such a grating we see first the light in its true position as it would appear through an unruled glass. Second, to the right and to the left of the light, if the grating is held so that the lines on it are vertical, other lights may be seen like the central one. If a red light is observed through the grating instead of a blue one, a similar series of lights will be noticed, but further apart. Lights of other colors will be spaced intermediate between these extremes of red and blue. If the light examined be white, then the blue rays of the light will be seen where the blue lights in the first experiment were seen, and the red rays where the red lights of the second experiment appeared, while the other colors will be merged together between, forming ribbons of color red at one end and violet at the other.

Light, it is well known, is considered to pass through space from a shining object as the ripples of water move out from where the surface is disturbed. In the diagram let the dotted lines represent the crests of a series of waves moving in the direction of the arrow. A B represents the grating encountered by the waves. The onward course of the waves will be arrested except at the openings, where they will pass on; but being free to turn to one side, they will take their course now in every direction, and the waves will take a circular form with the openings in the grating for their centers. As these waves continue out, the circles will become larger and more nearly straight; finally the waves from each opening in the grating will join with the waves from the adjoining openings, and the wave crests will again form in line as they were before they were broken by the grating. Besides this the reader will see how the wave crests may join in other ways. Thus, each wave front may join with the next behind to the right and form oblique waves. One set of these is shown on the diagram moving in the direction of the oblique arrow. The eye placed anywhere in front of this arrow will seem to see the light coming from the direction R, while it is really situated off in the direction L. The reader will see by studying the diagram how other oblique waves will be formed, as when each wave joins with the second behind either on the left or right. If we refer again to the diagram, and consider what the result would be if the wave crests were drawn further apart, we will see that the oblique waves would travel in directions still more slanting. This shows, when we remember that the red waves are the longest, why the red lights were seen in the directions most oblique.

Next consider how the moon would appear if such a grating were placed between us and it. On each side we would see the blue light of the moon, and close to these blue reflections the other colors would overlap in their order on the sides away from the moon; still further out this order of colors will be repeated a second and less perfectly a third and even a fourth time. But it was stated at the beginning the appearance was not that of the moon's light repeated on opposite sides of itself with the rainbow tints, but repeated in every direction so as to form a series of rainbow-colored rings. By placing a large number of such gratings in front of a light and having them turned so that the rulings will lie in every direction, this appearance might be imitated. How such a structure can ever happen in nature is not quite so clear.

Suppose a cloud to be composed of minute globules of vapor all of very nearly the same size and the same distance apart, then between these globules of vapor we will be able to trace parallel spaces lying in every direction. A cloud like this with its structure perfectly uniform would be our ideal set of gratings. A cane-seated chair bottom will form a familiar illustration of the structure in question, where between the perforations we can trace the parallel strands laced in different directions.

The grating of finely ruled lines has afforded a very accurate method of finding the distance apart of the waves of light. By observing how many degrees to one side the extra images are when seen through the grating, and making a diagram showing the same deflection of light as was observed, the proportion between the distance apart of the wave crests, or length of the light waves, and the distance apart of the spaces in the grating can be determined. With a grating having the number of lines ruled to the inch known, sixty-five thousand waves of blue light have been estimated to occupy the space of an inch.

If we know the length of the waves of light, we can as easily reverse our calculation and find the distance apart of the globules of vapor that formed the halo around the moon. It is necessary to know for the calculation the size of some one of the rings, and the writer would like to hear of any accurate observations of this. It may be estimated closely from the size of the moon, which is about one-half of a degree in diameter. Taking one degree as the distance from the center of the moon to the first blue ring, and multiplying the sine of this angle by the number of waves to the inch, we have for the product 1140; this is the number of globules of vapor which if placed in exact line would reach an inch.

The cube of this number gives the number of these tiny globules that are packed in the space of a cubic inch at a billion and a half.

Thus with the knowledge of the laws of light that scientific investigation has given us, we have been enabled to enumerate those minute specks of vapor in a cloud that was probably miles away.

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## ORIGIN OF THE CELLS OF THE HIVE BEE.

THE cell of the hive bee has for many centuries called forth the wonder of naturalists, and indeed of all observers. Why should, or how should, so comparatively humble a creature in the construction of its comb select that precise form which offers the greatest economy of form and material? Granting that the bee possesses no inconsiderable share of intelligence, we can scarcely conceive of her having made sufficient progress in the higher mathematics to select knowingly the precise angles which are best adapted to the object in view. Hence not a few writers, even to the present day, maintain that we have here a typical case of "instinct" in the old acceptation of the word—that is, of blind, unconscious, untaught action producing results which man can only reach by dint of highly cultivated reason. So many of these so-called instincts have lately found a scientific explanation that naturalists of the Old School have recognized the cell of the bee as one of their last entrenchments.

It is therefore very satisfactory that Herr K. Mullenhoff* has found a quite simple and satisfactory solution of the question, which neither admits of any mysterious instinct nor—on the other hand—credits the bee with the knowledge of the differential calculus.

Taking first a preliminary view of the case, we find that Pappus, fifteen hundred years ago, noted that bees constructed their cells in the form of regular six-sided columns, and proved mathematically the superiority of this shape to any other. In the last century Maraldi, and after him Réaumur, examined the form of the middle plate of the entire comb—*i. e.*, the bottoms of the cells formed each of three rhombs. At the instigation of Réaumur the mathematician König, in 1739, found by calculation the most suitable—*i. e.*, the most economical—of all possible forms for the middle plate, and ascertained that it must consist of pyramids formed by three rhombs having at the apex the angle 109° 28'. Maraldi had found this as the very angle actually employed by the bees.

These investigators show that each cell represents a six-sided column, bounded at the middle plate of the comb by a three-sided pyramid; the edges meeting at the deepest point of the cell form angles of 109° 28'; other angles of the same magnitude are inclosed by the short side of the hexagonal column and the two adjacent sides of the rhombs.

In the terminal points of the long sides of the prism there meet, therefore, four edges at angles of 70° 32'. The arrangement of the wax plates which compose the entire comb may therefore be formulated as follows: 1. On one edge there intersect each other each time three films, and these form with each other equal angles of 120°. 2. At the terminal points of the short sides of the prism meet in each case four edges at angles of 109° 28'. 3. In the terminal points of the long sides of the prism four edges cut each other at 70° 32'.

These properties correspond almost exactly with the laws which Plateau has discovered for his equilibrium figures—namely, at a liquid edge there intersect each other never more than three films, and these form with each other equal angles, and when liquid edges intersect each other in the interior of the figure they are always four in number, and form with each other equal angles.

Cells of exactly the same arrangement and the same angles as the cells of bees are obtained if numerous soap-bubbles of equal size are suspended in two parallel frames, and if the two systems of bubbles are approached until they touch each other. The soap-bubbles flatten themselves and form hexagonal prisms, terminating in Maraldi's pyramids, at the meeting-points of the two systems. The uppermost row of bubbles (that attached to the frame) would take the form of five-sided pyramids—*i. e.*, the exact form of the cells which are attached to the woodwork.

The conclusion is, therefore, very natural that this absolute agreement in the respective forms of the soap-bubbles and of the bees' cells depends on similar physical conditions in the construction of both.

If we observe the bees when building their comb, we find that, underneath the board to which it is attached, at least a dozen bees are clinging on each side, in such a manner that the heads of the bees on one side of the comb are exactly opposite to those on the other. As each bee, holding a ball of wax in its jaws, presses as far as possible upward and forward, the ball is converted into a plate by the pressure from both sides. At first this plate is not level, but is bent up and down corresponding to the pressure of the numerous heads of the bees.

As the bees press forward, the heads, as they meet, must always make way for each other in the direction of the least resistance—that is, in a newly begun comb a bee on one ride is pressed downward by its two competitors so as to come with its head exactly in the middle between three who stand opposite. As each bee on the one side presses with its head into the space between the three coming to meet her there is formed, by the pressure to which the soft wax is exposed, the middle plate so much admired on account of its "highest purposiveness." The pyramids of Maraldi are merely Plateau's equilibrium figures extended between the terminations of the sides of the prisms just commenced!

The "instinct" which the bees display is very simple; they press on with their wax upward and forward in two perpendicular layers. Of a skillful treatment of the wax there is no trace. The Maraldi pyramids are formed purely on physical principles, not by the conscious activity of the architects. The form of the head of the bee has no meaning as far as the shape of the bottom of the cell is concerned, since in consequence of the high temperature produced by the respiration of the bees and the continual pressure the wax is plastic in a high degree.

In an analogous manner the sides of the prism are also produced by the pressure which the cylindrical body of each bee undergoes from the six bees arranged around her on the same side of the comb. The process is exactly as when cylinders of equal thickness are formed into six-sided prisms by an equal pressure.

It appears that the procedure of each single bee is exactly the same as if she wished to construct a hollow cylinder. In fact, if we give them a thick cake of wax they bite and press in it round holes. When they work with an excess of material, as is often the case in the cells of drones, each single cell is a cylinder with a hemispherical bottom. If in such cells, which resemble test-tubes, the excessive substance is removed, the walls both of the prisms and the pyramids gradually take the usual form.

On an examination of a royal cell it appears, also, that the individual bee understands merely how to construct a hollow cylinder with a hemispherical depression at the end.

The fact that the bees frequently, and without any perceptible order, gnaw holes into the outer wall of the thick mass of wax of a royal cell, which naturally turn out hemispherical as the counter-pressure on the opposite side is wanting, shows that their artistic skill does not take a high rank.

When the cells are filled with honey, or with full-grown larvæ, they are hermetically closed with a lid of wax. The covered cell has then, as appears from numerous measurements, the exact form of the soap-bubbles above mentioned. The cells of the *Melipona* and those of single combs are also quite similar to soap bubbles. The detached "honey-pots" of the *Melipona* are globular, like a freely suspended bubble. If two such cells touch each other, they become flattened at the point of contact. Three such cells, if sufficiently close together, take such a form that their planes of contact intersect each other at an angle of 120°. If numerous soap-bubbles, of equal magnitude, are arranged in a single plane, they approach the form of wasps' cells. The phenomena of cohesion in the paper of wasps' nests differ entirely from those of water and of wax, and produce a dome shaped cell bottom and cover. If a stratum of soap-bubbles is suspended vertically, and is brought in contact with a second similar stratum, the form of the ordinary double comb of the hive bee is produced. The agency in the formation of these kinds of cells is to be sought not in a skillful movement of the jaws of the insects, but exclusively in physical causes. These are, in the case of wax, that the plastic and viscous material—just as is the case in soap-bubbles—gives way until a given space is inclosed by a minimum of surface. Hence planes are formed like those of Plateau's equilibrium figures.

The shape of the cells can no more be sought in the bodily structure of the bees than in their architectural skill. In view of the plastic character of the material and the manifold impulse to change of form connected with life in the hive the cells must soon, if equally arranged, take the form of six-sided prisms terminated by Maraldi's pyramids, even if the bees had globular or conical bodies.

Here Mullenhoff is rather inclined to assume that the general bodily form of the *Melipona*, the bee, and the wasp has been modified by the arrangement of their cells.—*Journal of Science.*

* Naturforscher und Berlin Entomolog. Zeitschrift.

## MICRO-PARASITES OF FISHES.

As a contribution to the stock of our knowledge of bacterial pathology we give here an abstract of some fresh investigations made by MM. Ollivier and Richet, published in *L'Union Medicale* of Sept. 29th, on the micro-organisms found in the lymph of fishes. By diligent examination these observers were able to detect microbes in the peritoneal, cerebro spinal, and pericardial fluids, and even in the blood of the heart. There could be no doubt, according to them, that the forms observed were really bacteria, for they possessed undoubted powers of locomotion, or, as the authors put it, of *mobility of translation.* It was found that the bacilli could be cultivated either in the natural lymph or in prepared bouillon. If some lymph and blood be collected with all the necessary precautions no decomposition takes place, even after several months. However, microscopical examination always reveals the incontestable presence of microbes. The maintenance of the limpidity and the absence of putrefaction do not constitute a sufficient proof of the purity of an organic liquid from a point of view of bacteria. A bouillon made from beef, neutralized and filtered several times, then heated in a sealed flask in a stove at a temperature of 105° to 110° for fifteen hours, is and remains a clear, pure fluid. Suitable quantities of this were introduced into some sterilized Pasteur's solution with all the essential precautions. At the end of a month no change had occurred. Inoculations were then made with blood or lymph, as above mentioned. Several specimens of blood and lymph had been kept in tubular pipettes. These pipettes were filled with sterilized bouillon and then sealed

at both ends, so that the cultures were rendered almost completely devoid of air. The liquid in the flasks and in the pipettes did not become turbid, even after several months. Nevertheless, at the bottom of the flask a light, small, flocculent deposit could be perceived with difficulty. But the microscope brought to light many kinds of micro-organisms, possessing motility and staining intensely with methyl violet. Multitudes of mobile forms were also to be seen in the tubular pipettes.—*Lancet.*

## VICTORIA, HONG KONG.

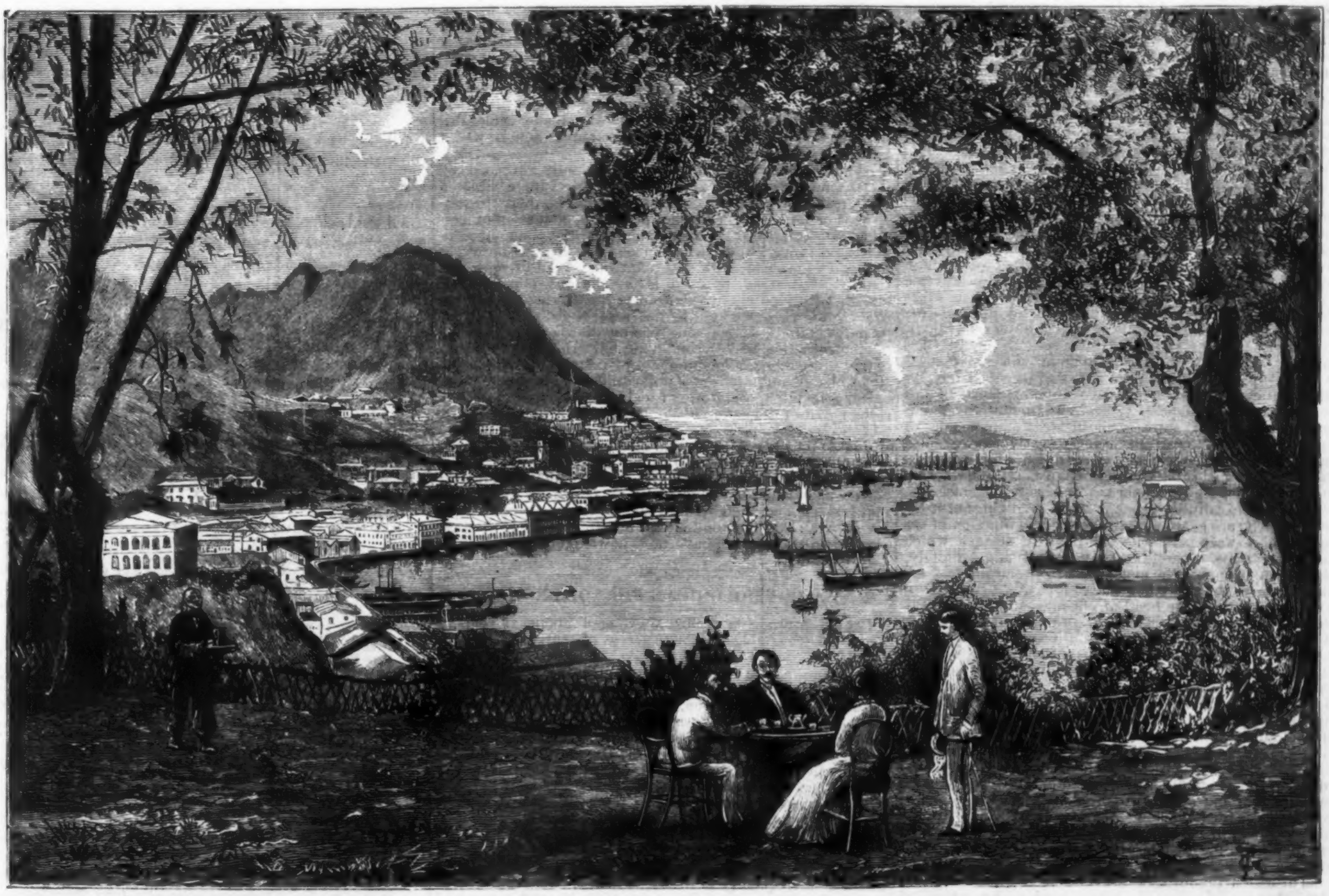
THE island of Hong Kong was ceded to the British Crown after the first Chinese war of 1841, but not colonized till 1843. At first the mortality among the troops and others was terrible. Many fell victims to a malignant fever, said to be caused by the upturning of the soil, a disintegrated granite. Of late years the sanitary condition has been improved, but much still remains to be done.

Forty years ago Hong Kong was a barren island, with a small population of fishermen and pirates. It is now the greatest commercial emporium on the coast of China, and must always be the pivot of war operations in the Far East.

A vast trade is carried on. British and foreign tonnage to the amount of two millions yearly enters the harbor, independent of an immense coasting trade.

The population of Hong Kong is some 150,000, 2,000 of whom are natives of India, and 8,000 whites, mostly English, with some Germans and Americans, and a very few French.

The Peak is the sanitarium for the sweltering town. Cool breezes blow there. Already some fifty dwelling-houses have been built, and more will follow when the promised wire tramway is made.



VICTORIA, HONG KONG.

Baron de Hubner compares the island to the Rock of Gibraltar on a large scale. "Victoria (the capital) is," he says, "charming, sympathetic, and imposing; English, and yet tropical. The streets, which are clean and well-paved, wind along the rock between houses, gardens, or stone balustrades. It is like Ventnor or Shanklin seen through a magnifying-glass, and under a jet of electric light. Everywhere there are fine trees; one may go on foot and yet always be in the shade, only no one dreams of walking. One cannot exaggerate the importance of this little island. Hong Kong is the hand; the colonies in the Straits of Malacca, Ceylon, Aden, and Malta, the arm; England the head and heart of that great British giant, which holds in its grasp the South of Asia and the extreme East."—*London Graphic.*

## THE CARE OF HORSES.

ALL domestic animals are subject to more or less abuse at the hands of man, but the horse seems peculiarly liable to injury and suffering, even while doing his best to serve him who ought to be his guardian and protector. In the wild state most animals are doubtless competent to take care of their own health, though nothing living is insured against misfortune, and death, by one means or another, is the common lot of all living beings. It may be a question whether, as a race, the cow has any stronger hold on life from being domesticated, than if forced to fight her own way in life against the elements and her animal enemies, yet we are apt to feel that a petted cow, one that is constantly well fed and well housed, has something to be thankful for, that she is not like the wild cows of the plains and jungles. The domesticated cow, and the domesticated horse, sheep, and hog, are certainly more fitted to fill the requirements of man than the untamed animals of the wilderness, but with civilization in man and domestication of animals comes a long list of diseases which neither the uncultivated Indian nor the wild animal knows anything of. Every advancing step in animal life, from the clam in his shell and mud home upward, seems to be a step toward greater possibilities of suffering and discomfort. The more sensitive the nerves become to pleasure, the more keenly they may feel pain.

There is no ground whatever for doubt that our most intelligent domestic animals are capable of suffering mentally as well as physically. The cow mourns for her calf that we have sold to the butcher, and allowed to be taken away right before her eyes. Young animals of all kinds, and some that are not so young, are often extremely "homesick" on being changed to new quarters, sometimes when only moved to a new manger in the same stable. Horses changing owners are frequently made entirely different animals morally by the change, particularly when going from a kind to an unkind master, and large volumes might be filled with true stories of dogs that have suffered mentally, some of them even unto death. Pleasure, pain, love, hatred, duty, hope, despair, chagrin, revenge, mirth, sympathy, pity, and, judging from appearances, even adoration and worship of superiors, are possible, if not all common, to all the higher forms of animal life.

Now, if the animals we own are susceptible of the same physical sufferings, and the same mental, and, for want of a better word, the same moral, feelings which we ourselves have, then most surely they have some rights that we, as their guardians and protectors, are bound to respect. We have no more moral right to unnecessarily drive a horse until his every hair is dripping with perspiration, and then leave him to stand and cool off in a cold, northwest wind, than we have the right to assassinate a brother or abuse a child. No humane person will deny this statement, and perhaps when all men become so humane that assassinating brothers and abusing children will be impossible, then our domestic animals will be treated as they, too, deserve.

Either naturally or from artificial causes, our domestic horse is a remarkably tough and enduring animal, otherwise we should have had no horse after the amount of abuse that has been heaped upon him. We work him hard, drive him all weathers, and expose him to all manner of dangers, and yet he lives through it all, or rather some do. We look at tough horses, however, much as we talk about rich men, forgetting the far greater number of both horses and men that drop out, and are left behind in the race. The truth is, we kill or ruin more horses by ill usage every year than what die or become worthless from old age. Are we then duly respecting the rights of our horses? There can be but one answer to this question, and yet there is at present no authority that can wholly prevent this abuse and unnecessary waste.

Perhaps, in this comparatively mercenary age, an appeal to the financial department of man's nature will be more productive of good to the horse than will any arguments relating to the right and the wrong in the matter. It does not pay to illtreat horses, and it does pay to treat them well. If it does not pay to load a horse with more than he can draw without injuring him, and then whip him because he does not pull the load, it does not pay to fool a horse by unreasonable treatment so that he can never know exactly what is wanted of him, and then whip him for being a fool. But it does pay to so treat your horse that he will have perfect confidence both in your judgment and your word; then he will do anything you ask him to do, provided it is within the range of possibilities. There is no great choice between a horse that is so much of a fool as to think he is "set" when he might pull his load easily and one that is foolish enough to pull himself to death when there is nothing to be gained by it. It does not pay to work a horse so hard one day that he will be good for nothing the next, when the work could just as well have been divided between the two days. It does not pay to feed a horse half rations, and then expect him to continue doing the full work of a well fed animal. Nor is it sound philosophy to suppose that a horse can very much or very long exceed his natural powers by crowding him with a surplus of hearty, stimulating food. Examples are frequent where this has been tried among members of the human family, and found wanting. Are we ready to admit that the animal is our superior in this regard? It does not pay to keep a horse constantly blanketed, when in a warm stable, and then on taking him out into the cold let him stand uncovered, and perhaps with a frozen harness on, while you are keeping warm throwing on the load he is to draw. It does not pay to make your horse draw your lazy body up a steep hill on top of a heavy load, when you yourself are shivering with cold, and would be far more comfortable and safer from bodily ailments if you would get off and walk yourself warm. It does not pay to come in with your horse tired, wet, and with his legs covered with mud, and then let him have a hearty supper without first rubbing him into a condition of comfort.

It does not pay to let a horse's shoes remain on his feet until the feet are ruined, for the want of setting or removing. Nor does it pay to let a horse's clinches get out where they will cut the flesh and make sores that will be slow to heal, even after the cause of the sores is removed. It does not pay to let a hard, ill-fitting harness wear out the hide, and make sores which can never heal, except the animal be turned out to a period of idleness, when a well fitting harness might just as well have been used at first, and all the time. It does not pay to let a farm horse, that has work enough to do at home, to irresponsible young villagers who don't now how to take care of themselves, to go off to celebrate the *Fourth of July.* Neither would it be right to refuse to drive your horse at his best safe gait to accommodate a neighbor who you believe really needs a doctor; and if you value your neighbor more than your horse, and choose to drive beyond a safe gait, you have doubtless the right to take the risk upon your own shoulders, and let your conscience adjust itself to the circumstances. Your neighbor's life may be worth more to you or to others than many horses.

A great many horses, however, are sadly abused from the fears, whims, or caprices of their drivers. Some men are ever ready for some excuse for putting a horse to his utmost endurance. But of all the ill treatment to which our faithful horses are subjected, there is nothing compared to that received at the hands of a drunken owner or driver, whose character, for the time being at least, if weighed by any just measure of intelligence or conduct, would be vastly below that of the noble, faithful animal that is suffering through his driver's abuse. We should learn to treat our animals better than they often are treated, and some should learn to take better care of the animal's owner.—*N. E. Farmer.*

THERE is now being made at the sugar works of Macfie & Sons, Liverpool, England, the largest boring yet attempted by a single bit. The upper part of the bore is 2 feet 10 inches in diameter, reducing to 2 feet 6 inches, at which diameter it is proposed to drill to a depth of 1,000 feet, or through the red sandstone. The cast steel boring head, with cutters, guide, and rod, weighs $1\frac{1}{2}$ tons. A flat hemp rope, 5 inches wide by $1\frac{1}{4}$ inches thick, actuates the drill from a large drum connected directly with the engine.—*Iron.*

## THE NATURE OF THE EXISTENCE OF MATTER.

E. R. KNOWLES.

"WE feel but the pulse of that viewless hand
Which ever has been and still shall be,
In the stellar orb and the grain of sand,
Through Nature's endless paternity."

Philosophers are now obliged to refer all the phenomena of the universe to the action of a substance occupying space, which communicates light, heat, electricity, and gravitation from one body to another, and mental emotion and imaginary ideas from one mind to another. This omnipresent medium is called *Etherium*, or *the ether*. Most scientific men are fully convinced of its reality. It is a necessary inference from the following facts:

1. The planets "influence each other," and are all attracted by the sun.

2. Philosophers agree that the atmosphere does not extend more than two hundred miles from the earth's surface.

3. Heat, light, electricity, magnetism, and gravitation operate in an exhausted receiver just as well as elsewhere.

4. One mind sometimes influences another independently of ordinary sensation or muscular motion, without contact or perceptible connection.

Says Professor Tyndall, "The domain in which this motion of light is carried on lies entirely beyond the reach of our senses. The waves of light require a medium for their formation and propagation, but we cannot see, or feel, or taste, or smell this medium. How, then, has its existence been established? By showing that by the assumption of this wonderful intangible *ether* all the phenomena of optics are accounted for with a fullness and clearness and conclusiveness which leave no desire of the intellect unfulfilled. When the law of gravitation first suggested itself to the mind of Newton, what did he do? He set himself to examine whether it accounted for all the facts. He determined the courses of the planets; he calculated the rapidity of the moon's fall toward the earth; he considered the precession of the equinoxes, the ebb and flow of the tides, and found all explained by the law of gravitation. He therefore regarded this law as established, and the verdict of science subsequently confirmed his conclusion. On similar, and if possible on stronger grounds, we found our belief in the existence of the universal ether. It explains facts far more various and complicated than those on which Newton based his law. If a single phenomenon could be pointed out which the ether is proved incompetent to explain, we should have to give it up; but no such phenomenon has ever been pointed out. It is, therefore, at least as certain that space is filled with a medium by means of which suns and stars diffuse their radiant power as that it is traversed by that force which holds not only our planetary system, but the immeasurable heavens themselves in its grasp." And again, "The ether which conveys the pulses of light and heat not only fills the celestial space, bathing the sides of suns and planets, but it also encircles the atoms of which these suns and planets are composed. It is the motion of these atoms and not that of any sensible parts of bodies, that the ether conveys; it is this motion that constitutes the objective cause of what in our sensations are light and heat." Again he says, "Two atoms of oxygen and one of sulphur constitute the molecule of sulphurous acid. Now it has been recently shown, in a great number of instances, that waves of ether issuing from a strong source, such as the sun or the electric light, are competent to shake asunder the atoms of gaseous molecules. A chemist would call this 'decomposition' by light, but it behooves us, who are examining the power and function of the imagination, to keep before us the physical images which underlie our terms. Therefore, I say, sharply and definitely, that the components of the molecules of sulphurous acid are shaken asunder by the ether waves. . . . Here, then the ether waves untie the bond of chemical affinity, and liberate a body—sulphur—which at ordinary temperatures is a solid, and which therefore soon become an object of the senses." To other modifications of ethereal action are referable muscular motion, sensation, and all the other phenomena of the material universe.

Says Professor J. Stanley Grimes, "Light cannot penetrate boards and stone walls, but magnetic force can do so; for a magnet affects iron-filings through such obstacles almost as if there was nothing in the way; and so also does gravitation. It is plain that if we could perceive through the medium of this magnetic force instead of light, we could see through boards and walls as easily as the magnet operates through them; for the magnet operates in the dark just as well as in the light. We must conclude, therefore, from the great number of facts which we have upon the subject, that there is a motion of Etherium, different from light, by means of which the force of gravitation is communicated; and another modification of etherean motion, by means of which magnetism penetrates through opaque bodies. It, therefore, requires no stretch of the imagination to admit a modification of ethereal force which affects the brain and its organs, and produces Consciousness and Clairvoyance in a subject who is, by the process of etherean induction, brought into communication with it. If we analyze a sunbeam, we can demonstrate that besides light and heat it contains another kind or motion of Etherium, different from light and heat, which produces powerful chemical effects, and yet we have no sense given to us by which to enable us perceive by its means, though it may sometimes abnormally induct us and produce clairvoyant perception.

"It seems to me, that there cannot be a doubt in the mind of a philosopher who examines the subject carefully, that there is a peculiar form of ethereal force, which has with some propriety been called *Animal Magnetism*, and which is concerned in producing all the phenomena of animal life and all the wonders of Etheropathy and Mesmerism. We seem forced to this conclusion as the only one to account for facts which we are not able to controvert."

It is well known that orators often exercise a so-called magnetic influence over their hearers. It has been proved that mesmeric susceptibility is owing neither to the imagination, nor the credulity, nor the nervousness of the subject, and that when a subject is in a state of etheropathic sympathy, produced by induction, ideas can be communicated from the mind of the operator to that of the subject, and the subject made to act by the mere silent will of the operator, without any indication being given to the subject by the word, look, or act of any one as to what the operator has in mind.* These last mentioned facts have led some scientific men to suppose this ether to be homogeneous with, or at least intimately connected with, that immaterial, simple substance, the soul.

The idea that the will of man can direct ethereal action in such a way as to produce etheropathy or mesmerism is perfectly consistent with the nature of the will. In the case of the electric eel, we have an instance of the will directing electricity in such a way as to paralyze the limbs of animals at a great distance, and even to produce death.

If, then, the electric eel can habitually and instinctively direct by its will *one* modification of ethereal action, it is reasonable to suppose that the will of man can direct *another*.

In view of the facts herein already adduced, the only way whereby to account for certain incontrovertible facts is to refer matter, as well as light, electricity, etc., to the immaterial substance called the ether. All the difficulties with which philosophers now meet in explaining various phenomena by the action of the ether, arise from their not explaining the very existence of matter by ethereal action.

"That which truly is, or essence," is the proper meaning of substance. *Substance* is "the ultimate point in analyzing the complex idea of any object. *Accident* denotes all those ideals which the analysis excludes as not belonging to the mere being or nature of the object."

The substance of all matter is the ether, this "creating and forming spirit, which is with us and not of us." The accidents of any object are its peculiar modifications of ethereal action.

The ether acts in space, directed and compelled in its action by the Divine Will. There are:

1. Simple modifications of ethereal action.
2. Combinations of such modifications.

The accidents of objects are constantly sustained by the Divine Will in accordance with fixed and permanent laws. This theory explains the phenomena of matter by the action of the ether; but it teaches neither that the ultimate reason of all movement is a force primitively communicated at creation, a force which is everywhere present in all bodies, but differently limited; nor that any such force is inherent in the ether; nor yet that force is transmitted through the ether. I hold that the Divine Will constantly sustains by sympathetic induction all the modifications of ethereal action which constitute matter.

At any point in space the ether is constantly governed by the Divine Will in such a way that an object there situated has a real existence *there*, whether any one is there to perceive it or not, its real existence being a combination of certain modifications of ethereal action; and the same object is presented to every spirit who happens to come or be brought into communication with that point in space, this presentation being governed by fixed laws; and any one who has already perceived a particular object knows that upon going again to the place where it is, the same object will be perceived by him, *i. e.*, the same combination of modification of ethereal action will be communicated to his soul by means of this same ether as a medium and by certain other modifications, and combinations of modifications, of ethereal action.

Our perception, therefore, of real ideas or material objects is the result of the action of the Divine Will on our minds, and the Eternal Spirit constantly sustains and presents these real ideas for the contemplation of created spirits, but they exist out of the minds which perceive them.

This theory does not merge the creature in the Creator; and does not make God the agent or power in everything that is done, and thereby lead us to the same point with Hume, viz.: that the mind is but a mere series of impressions; and that we can have no knowledge of it.—*Kansas City Review.*

* "If we proceed still further, we gradually, in many subjects, acquire a power of moving their organs by merely willing and without expressing our will by any sign; but, in these cases, though neither assertion nor sign is necessary to influence the subject, yet an assertion, if made, is wonderfully potent."—(Grimes' Etherology, etc., p. 149.) "Let us now consider, that when a subject is perfectly inducted, the mere silently expressed *will* of the operator can influence him, and cause him to move or feel in any desired way. No assertion in this case is necessary—no sound—no sign—no external muscular motion. There is nothing but the operation of the silent but potent will."—(Ibid., p. 147.

## A PHYSIOLOGICAL PHENOMENON.

LOUIS LOUDENKI, a Polish Jew, aged about 29 years, a remarkable example of the success of surgical science, arrived the other day in Buffalo. To what has already been made public concerning this man and his strange case, the Buffalo *Courier*, whose reporter visited Loudenki at the office of Dr. Warren, adds many interesting particulars. The story of his experiences would be incredible but for the fact that they are said to be substantiated by the police records of Austria and by the medical records of Vienna, in whose medical school, one of the first in Europe, he was long a living curiosity, whose manifestations of life were a subject of interest to the six thousand students attending the famous college of the Austrian capital.

Eight years ago Loudenki attained his majority, and on the death of an uncle came into the possession of $10,000, which in his country would be called a fortune. His business called him frequently to Australia, Italy, and other distant parts. In the month of February, 1877, he and a party of five others were crossing the mountains in Roumania with their goods on horseback, Loudenki carrying his all strapped by his side, when a party of gypsy robbers, armed with swords, swept down on them and began the work of slaughtering their victims in the hope of plunder. The travelers were one by one knocked down and then dispatched by drawing the short sword across their throats. Loudenki was fourth on the list of victims so dealt with, but in his case only the wind-pipe and œsophagus, or food-pipe, were severed, the jugular vein remaining unharmed. The robbers on looking over their booty and finding that Loudenki was the wealthiest, took exceptional measures to insure his death. Tying a rope round his neck, they hung him on an adjoining tree and left him suspended for dead. But, through the aperture in his wind-pipe, the injured man still contrived to breathe, and, after a lapse of forty-eight hours, was rescued by a band of Roumanian peasants, who at first were difficult to persuade that he was not dead. He was conveyed to a warm cabin, and, notwithstanding the treatment he had received and the exposure to a temperature of intense cold, he showed signs of animation just as the peasants were preparing for a decent burial. Ten days after the injury the sufferer reached Vienna, where he was placed under the care of a skillful surgeon named Schraeder, with encouraging results.

"For twenty-six days," said Loudenki, "I was unable to swallow food, and for 186 days I was in an unconscious state. Liquid food, consisting of wine, milk, and extract of beef, was administered by injection. For two years I lived entirely on this kind of food." In Vienna a shuttle shaped instrument, or curve sound, partly silver and partly galvanized steel and vulcanite, was made to act as a dilator to obviate contraction of the injured air passage. The dilator resembles an instrument constructed some years ago by Professor Edward M. Moore. By placing it in the passage over night it is hoped that in a month or two the stricture caused by the injury will be altogether overcome. It is believed that Loudenki is the only living subject who presents the features of having his throat cut in this way, showing a complete severance of the bronchial tube and also of the œsophagus, or tube which conveys the food from the mouth to the stomach.

It was a curious spectacle to see Loudenki smoking a cigarette, inhaling with his mouth and letting the fumes escape through the aperture in his throat, or putting his finger on the tube and allowing the smoke to issue from the mouth and nostrils.

The wound was explained by Dr. Warren as extending from the inner sides of the carotid arteries, also between the inner sides of the two jugular veins. "The hanging," said the doctor, "saved the man's life by the pressure on the blood vessels not allowing the blood to enter the lungs, which would have been attended by suffocation." On removal of the tube the open circular wound, large enough to admit a man's finger, disclosed some features which the doctor explained to be of great medial interest. Looking upward could be seen the glottis and vocal cords; looking downward there was visible the large bronchial tube leading to the lungs. "The action of these in the living subject has never heretofore been seen," remarked the doctor.

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